SCIENCE

VOL. 81 FRIDAY, APRIL 5, 1935 No. 2101

The American Association for the Advancement of Science:
Facing the Erosion Problem: H. H. BENNETT 321

Presentation of Professor Julius Arthur Nieuwland, C.S.C., for the Award of the American Institute Medal: PROFESSOR MARSTON TAYLOR BOGERT 326

Obituary:
Herdman Fitzgerald Cleland: DR. PERCY E. RAYMOND. *Recent Deaths* 330

Scientific Events:
The Annual Report of the Director of the Field Museum of Natural History; Soil Erosion Control; The Annual Meeting of the American Public Health Association; The Los Angeles Meeting of the Pacific Division of the American Association for the Advancement of Science 332

Scientific Notes and News 334

Discussion:
The Nebraska Earthquake of March 1, 1935: PROFESSOR A. L. LUGN. *Synchronous Flashing of Fireflies Experimentally Induced:* JOHN BONNER BUCK. *Tree Rings in New England:* PROFESSOR CHARLES J. LYON. *National Welfare, Business Profits and Individual Benefit:* DR. GEORGE W. HARTMANN. *Chinese Magic Mirrors:* JOHN KAISER 338

Scientific Apparatus and Laboratory Methods:
High Rotational Speeds in Vacuo: E. G. PICKELS and PROFESSOR J. W. BEAMS. *A New Method of Differentiation of Amylases and Starches:* K. VENKATA GIRI 342

Special Articles:
The Significance of the Persistence of the Crystalline State above the Melting Point: PROFESSOR ROBERT E. BURK. *The Etiology of Epidemic Colds in Chickens:* PROFESSOR CHARLES S. GIBBS. *The Heart Rate in Heavy Water:* DR. T. CUNLIFFE BARNES and J. WARREN 344

Science News 8

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.
Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

FACING THE EROSION PROBLEM[1]

By H. H. BENNETT

DIRECTOR, SOIL EROSION SERVICE, U. S. DEPARTMENT OF THE INTERIOR

THE productive agricultural lands of the United States are being seriously impaired and even destroyed on a vast scale. The plant nutrients and the soil body itself are being removed from fields and over-grazed ranges at an ever-increasing rate under existing methods of unwise land usage, with the effect not only of impoverishing and even destroying the uplands but of covering fertile lower slopes and productive alluvial plains with poor subsoil material washed out of the hills. Moreover, the products of erosion are filling stream channels and costly reservoirs; increased runoff from soil-stripped, gully-riddled slopes is increasing the hazard of floods; and many streams muddied with silt and colloidal clay have been deserted by valuable species of fish. This irreparable damage is increasing at an accelerated rate. Centuries would be required to build back the soil swept out of the fields and overgrazed pastures of the nation by this process that continues with every rain heavy enough to cause water to run downhill. We have been maintaining our agricultural production at the expense of the substance of the land.

The average citizen is unacquainted with the gigantic proportions of this devastating agency of uncontrolled erosion by wind and water. Educators, business men and statesmen, even our specialists—many of our engineers and agricultural experts—do not yet realize that more than 75 per cent. of the country consists of sloping land, all of which is subject to erosion in some degree where used for clean-tilled crops or where subjected to unwise grazing. Nor is it generally known that the average depth of the more productive topsoil of these erosive lands is only about 7 or 8 inches, or that this thin covering, representing the farmer's principal capital, is being swept

[1] Presented before Section O, American Association for the Advancement of Science, Pittsburgh, Pa., December 28, 1934.

completely away at rates ranging generally from about 3 to 60 or 75 years, depending on the kind of soil, the declivity of the land, the rainfall and the type of agriculture.

A thriving agriculture is the basis of national prosperity. When the rich, humus-charged surface layer is stripped off the land, it can not be restored, and without this productive covering agriculture generally can not be prosperous, whether prices are up or down. The world is strewn with ruins of once flourishing civilizations whose basis of continuance has been destroyed by erosion. No greater problem than the control of erosion confronts the nation to-day. The problem is national in character and scope. The injurious effects touch directly or indirectly the interest of every citizen.

White Man's Method of Land Use

What has happened in this country since the white man took over from the Indians the vast expanse of virgin soil, covered with far-flung forests of valuable timber or clothed with luxuriant prairie grasses, is a tragic story. Faster, probably, than any nation or race we have been impoverishing and destroying our indispensable agricultural lands. Other parts of the world, such as the highlands about Antioch, Syria, have been devastated by this wasteful process and the people have deserted the skeletonized areas, but their lands were used for thousands of years. We have used ours only a little more than 250 years, most of it for less than 75 years. In this short time we have succeeded in putting through a gigantic undertaking of land degradation, and this without stopping to think seriously of what we have been doing. Only recently have we begun to measure the impoverishing effects of erosion, and even now we have scarcely begun to apply the scrutiny of research to this menacing problem.

A short time ago it was estimated, on the basis of existing surveys, that at least 35 million acres of formerly cultivated land had been essentially destroyed by erosion. Now, on the basis of a nation-wide reconnaissance erosion survey, recently completed by the Soil Erosion Service, it is found that the area of formerly cultivated land largely essentially ruined amounts to not less than 100 million acres. This is the equivalent of 625,000 farms of 160 acres each, an area nearly equal to the combined extent of Ohio, Illinois, Maryland and North Carolina. Isolated fields and small parcels of ground between gullies and soil-denuded slopes can still be cultivated on a patch-farming basis, but fully half of the area is physically unfit for cultivation, chiefly because of severe gullying, with the other half about as bad.

In addition, approximately 125 million acres of the land now in cultivation have lost all or the greater part of the topsoil, and as the result these denuded lands are from about 2 to 10 times less productive than was the virgin soil.[2] They are not only less productive, but they are more difficult and expensive to plow and rainwater flows over the exposed impervious clay more rapidly to increase the rate of erosion, the rate of silting of stream channels and reservoirs and the volume of floods.

Thus we have permitted tens of thousands of farmers to become subsoil farmers, which means generally something very closely related to bankrupt farming on bankrupt land. Moreover, the virtual ruin of the soil is essentially of a permanent character, jeopardizing the well-being of generations to follow.

The Way Out

There is one way and only one way out of this menacing national situation of land depletion by erosion, and that is to put through as speedily as possible a properly coordinated, complete and adaptable soil-conservation program on all the remaining areas of good land needing protection. Such a program calls for treatment of the land in accordance with the specific needs and adaptabilities of the many different kinds of land. Any other method of approach will merely postpone the accomplishment of those things that must be carried through if this is not to be probably the greatest nation of poor subsoil farming of all the earth's history. Postponement of this inescapable task simply means a more difficult and costly job ahead.

We have been fighting erosion in some parts of the country for more than 75 years, notably in the southeastern Piedmont region; but we have not overcome the enemy. Even in this older agricultural section the evil has been spreading much faster than the application of efficient corrective measures. Our attack has been largely one in which a single implement was employed, that is, hillside ditching and hillside terracing for slowing down the runoff. On gently sloping land this single-track method of combat has accomplished much good, but on a very large area of steeply sloping, highly erosive soil the practice has, in the long run, done more harm than good. For example, the recently completed nation-wide erosion survey shows that considerably more than two million acres of terraced land in the state of Georgia alone have been essentially destroyed for further practical crop use. The building of terraces where they were not applicable, or failure to build them correctly and properly maintain them, hastened the permanent downfall of these formerly fertile slopes.

[2] H. H. Bennett, *The Geographical Review*, V. XXIII, No. 3, p. 431, July, 1933.

In spite of the obvious physical impossibility of controlling erosion except by making extensive use of vegetation in our control measures, many specialists to-day are boldly asserting that an engineering method of attack—one employing a single implement of combat—is the complete and final answer to the erosion problem. Since erosion begins wherever water accumulates in sufficient quantity to flow down hill across unprotected areas, the only possible purely engineering method for actually controlling an agency of this kind, if there is any truth in mathematics, would be to build extensive walls, as those found in parts of the Mediterranean Basin, with which it would be possible to cultivate the land on the level. Labor conditions and topographic and other physical characteristics of the land utterly preclude this method of control in America, for the present at any rate. Such laborious procedure is not essential to success; there are other methods—effective, practical methods, as those now being used with a high degree of success on the demonstrational areas of the Soil Erosion Service. These methods will be referred to later.

Need of Education

A depressing aspect of the whole erosion problem is that we have assumed the country has enough land to withstand the most violent misuse. Many have looked upon soil wastage by accelerated erosion as a process over which man has no control, and some have stubbornly refused to recognize any distinction between the exceedingly slow *geologic norm of erosion* (generally harmless) and the devastating *accelerated erosion* brought about through the instrumentality of man. With reckless prodigality, all kinds of land have been used for a great variety of crops, as if all of it, good and bad, steep and level, were equally adapted to these diverse uses.

The average American has no particular love for the land and little understanding of it. The explanation is fairly simple. Colonists pouring in from great reservoirs of population in Europe began a westward march across the continent under conditions that led them to believe the American continent was endowed with limitless and inexhaustible supplies of land, forest and game. Now that our frontiers have disappeared in the Pacific, and are reappearing in the East and West, we are beginning to appraise the gigantic waste that went with that rapid occupation of the country, which we have liked to boast of as the "conquest of America." Vast stretches of forest are gone, the buffalo have been killed, some species of game-birds have been exterminated, and we find hundreds of millions of erosion-made gullies and tens of millions of acres of erosion-exposed clay subsoil where there was not a single gully of this kind nor one acre of man-induced, freshly exposed subsoil when the country was taken over by the white man.

It is true that erosion had been going on in many parts of the sparsely vegetated western regions, where great canyons had been dug out, before the advent of the white man. But we are not concerned with that phase of erosion, nor with the exceedingly slow process of normal or geological erosion, such as is responsible for the building up of fertile stream bottoms throughout millions of years. It should be perfectly understood that the accelerated erosion we are considering is the product of excessive runoff caused by the reduction of the absorptive capacity of sloping land as the result of removing the stabilizing cover of vegetation and the cultivation and grazing of the land since the occupation of America by the white man.

Absorption, runoff and erosion are interdependent processes, and for all practical purposes may be considered as a single 3-phase physical agency. These processes—rather, this agency is profoundly influenced by slope, climate, soil, density of the cover of vegetation and the use made of the land. When the normal vegetative cover is removed the soil is laid bare to the full destroying effects of violently rushing rainwater and hurtling wind. The process of plowing vitiates or tears down the effective porosity of the virgin soil, closing conduits made by earthworms and plant roots, and disrupting the porosity that goes with the natural granular or loam-like structure of the soil. With further cultivation the humus content of the soil—the sponge-like binding material—is dissipated by processes of decomposition and oxidation. In this way man effaces within a few brief years what nature has taken centuries, even thousands of years, to build. If we observe some of the lessons of nature, making liberal use of vegetation in various adaptable cropping practices and eliminating the steeper slopes from cultivation, these same areas can be conserved almost indefinitely. But we have not been thinking along these lines, and upon a foundation of misconception about the extent and durability of our good farm lands, plus a vast amount of stark ignorance concerning erosional processes and rates, and the dire effects of these activities on the productivity of the land, we have built a far-reaching system of farm tenancy which still further adds to the sinister import of this ignorance and indifference with respect to how the land is used and wasted.

Runoff and Erosion from Different Soils Undergoing Various Cultural Treatments

Quantitative measurements of soil and water losses from comparable areas undergoing different cropping treatments will be given for but one important agricultural soil.

Taking measurements made at the Bethany, Missouri, erosion station on one of the most extensive soils in the rolling sections of the corn belt (the *Shelby silt loam* and its very close relative, *Shelby loam*), it has been shown that from about the average regional slope (8 per cent.), devoted continuously to corn, the average annual soil loss from a representative slope cross-section of 73 feet has amounted to approximately 60 tons per acre, along with a loss of 27 per cent. of the total precipitation as immediate runoff. As against this, the corresponding losses from exactly the same kind of land, receiving the same rainfall, seeded to thick-growing, protective crops, have been very much less. Under alfalfa the loss of soil has been at the rate of only .21 of a ton per acre annually, along with a runoff of only 3.41 per cent. of the total precipitation; under timothy the corresponding losses have been at the rate of .32 of a ton of soil an acre and 7.74 per cent. of the precipitation. In other words—and this is of tremendous significance in connection with the whole national plan of flood control, land utilization, prevention of silting and conservation of our indispensable agricultural domain—alfalfa has been 289 times and grass 190 times more effective than corn in holding soil on the slopes where it belongs. The respective efficiencies of the two crops in relation to rainfall retention, as compared with corn, have been approximately 8 and 3½ times as great.

For the same period, the same type of land kept bare of all vegetation has lost an average of 112 tons of soil per acre per annum, or more than 500 times as much as was lost from fields devoted to alfalfa. From fields where a 4-year rotation of corn, wheat and clover was practiced—fields having exactly the same soil and slope and subjected to the same rainfall—the soil loss has proceeded at the average rate of only 9.9 tons an acre annually, while the water loss has been at the rate of 11 per cent. of the precipitation, showing that a good crop rotation is a highly effective method for minimizing both runoff and erosion.

These measurements indicate that under continuous corn production, on 8 per cent. slopes of this region, about 20 years would be required to strip off the top layer of productive soil, down to stiff, impervious clay that bakes in dry weather and sheds the rainfall at a terrific rate. On 4 per cent. slopes, approximately 30 years would be required to complete this job of surface denudation. Under grass something like 3,900 years would be required to remove the topsoil from 8 per cent. slopes of *Shelby* soil.

The *Shelby* soils, together with their closely allied types, constitute the principal kind of land within an area of about 11 million acres, in northern Missouri, southern Iowa, southeastern Nebraska and northeastern Kansas. Our surveys indicate that of this area about 4,500,000 acres already have suffered severely from sheet washing, and that 500,000 acres have been essentially ruined by gullying following sheet erosion.[3]

Damage of Valley Lands by Overwash of Erosional Debris

In numerous localities deposition of the products of erosion has had a disastrous effect with respect to channel choking, filling of reservoirs and covering of formerly good agricultural land with inferior soil material. Soil surveys in the Piedmont section of South Carolina had, prior to about 1930, classed 72 per cent. of all the alluvial land mapped within that area as *Meadow*—that is, as wet to swampy stream bottom so changed from the original condition by overwash that it was impossible to classify it correctly under definite soil type designations.[4] The stream channels had been choked with erosional debris, overflows were more frequent and most of the land, though formerly cultivated, had been abandoned, and supported a growth of willow, alder, sweet gum, smilax, blackberry, rushes and cattail. This is about the condition that now characterizes most of the alluvial soil of the entire Piedmont region from Virginia southward.

Soil types are being mapped in various parts of the country which represent recent wash from cultivated uplands. These soils generally are much lighter colored than the old alluvium which they have covered, and they are more diverse with respect to texture of material. Generally they are considerably lower in content of organic matter, especially where erosion of the uplands has proceeded to such an extent that relatively poor subsoil material is being deposited over the surface of the bottom lands. In this way some of these recently formed alluvial soils, that is, soils formed since the beginning of agriculture, represent an approximation of inverted upland soils transferred to the alluvial plains below.

Usually the line separating the buried pre-agricultural alluvial soil from that formed since the beginning of cultivation of the uplands is so sharp that it can be easily photographed. In many instances the depth of the soil belonging to the latter stage of deposition exceeds the entire depth of the old alluvium from its surface down to the bed of the stream channel or even to bedrock in some instances. Characteristically, the texture of the older material is distinctly finer than that of the recent

[3] H. H. Bennett, pp. 474–488, *Transactions, American Geophysical Union*, Nat'l Research Council, 15th annual meeting, 1934, Washington.

[4] H. H. Bennett, South Carolina teacher-training program (mimeographed), p. 20, Bureau of Chemistry and Soils, U. S. Dept. of Agriculture, 1932.

deposits, darker colored and much more uniform. These facts, coupled with the fact that the covering of recent material often is as deep as and in some places deeper than that below, show conclusively that the characteristic suspension of the flood waters of the preagricultural stage was entirely different from that of the latter stage. Other profile characteristics, considered in connection with the obviously much longer period involved with deposition of the pre-agricultural material, show conclusively that sedimentation before the coming of the white man was from flood waters of comparatively slow velocity. Study of the profiles of these alluvial deposits in the older agricultural areas affords abundant evidence that floods along most of the streams within areas of rolling topography, as well as silting, have increased greatly since the beginning of agriculture.

Sedimentation of Reservoirs

Many of the storage reservoirs of the southern Piedmont have been filled to the top of the dam within less than thirty years. One major reservoir on the Colorado River in Texas was largely filled in the course of about five years. The Elephant Butte Reservoir in New Mexico, estimated in the beginning to have a life of 220 years, at the present rate of silting probably will be useless in times of protracted drought at the end of about 60 years. The Harding Reservoir in California filled as the result of one rainy period following a serious fire on the watershed.

Between 1922 and 1934 the watershed of the Gibraltar Reservoir (200 square miles), near Santa Barbara, California (the dam of which was completed in 1920), has, according to records recently made available, suffered from 11 major fires, which have progressively increased the area burned to 87 per cent. of the total watershed. Between 1920 and 1925 the silt content of the water entering the reservoir averaged .95 of one per cent.; this increased to an average rate of 1.8 per cent. for the period 1925–1931, and to an average of 2.9 per cent. between 1931 and 1934. The rate of silting for this 14-year period increased from 160 acre-feet per annum to 600 acre-feet per annum.

Practical Soil Erosion Prevention

Effective control of erosion primarily involves reduction of the soil-transporting effect of meteoric waters by those practical methods of land treatment which minimize the rate of off-flowage, thereby causing a larger proportion of the rains to sink into the ground at or near where they fall. These measures will be, principally: (1) Various adaptations of thick-growing vegetation to practical farm operations, (2) use of engineering structures and mechanical procedures where applicable, and (3) retirement of steep, excessively erosive land from cultivation. Our knowledge of the soils of the country, the topography, the rainfall, the types of agriculture and the rates of erosion and runoff from different kinds of land subjected to various cropping treatments and other uses is now sufficient to reveal finally and conclusively the physical certainty that until the distinctly different kinds of land are treated in accordance with their particular needs, as determined by the physical factors involved, it will be impossible to make any effective headway of a permanent nature against accelerated soil erosion, against the hazards of silting of stream channels and reservoirs, or against destructive floods within numerous drainage basins. These physically determined facts take the question outside the domain of opinion; and on the basis of this accumulated knowledge the Soil Erosion Service is proceeding as rapidly as possible, and for the first time in the history of the country, to put through large-scale, impressive demonstrations of erosion prevention and control, such as will show, and to a considerable extent already have shown, that it is practicable to control accelerated erosion by an integrated method of land treatment—that is to say, by using all known practical measures for minimizing the runoff from all the erosive land within a given watershed.

The Soil Erosion Service now has thirty-two erosion projects in thirty-one states, comprising an area of approximately twenty-eight million acres. There is immediate need for increasing these demonstrational projects to some fifty or sixty major areas, along with a considerable number of smaller outlying areas. By this it is meant that there should be complete demonstrations in those more important distinctive geographic regions of the country where erosion is known to be a serious problem and where the method of attack must be shaped to accord with differences in soil, topography, rainfall and agricultural practices.

The United States Debates and Delays

When we consider the fact that in some other parts of the world erosion is being effectively controlled by wise use of vegetation, cropping methods and engineering measures fitted, through integrated land-treatment programs, to the different kinds of land in accordance with their individual needs, it seems a pitiful situation that this great nation should stupidly pin the security of its agricultural domain upon a single method of erosion combat, namely, the use of engineering structures alone. When we see the descendants of the Incas giving almost complete protection to steep Andean slopes with rather simple methods of vegetative control and field arrangement, on land that was in cultivation at the time of the Spanish conquest about 400 years ago, it would seem that we actually

have much to be ashamed of in our record of disastrous land misuse. When we are told that Italy is spending $500,000,000 on her "Boniface Integrale" program of land conservation and reclamation, it would seem that those of us who have a real interest in the continuing welfare of the United States should be moved to action whenever those who know something of the subject assert that the nation can not afford not to spend now and in the near future whatever is necessary to conserve our remaining areas of good agricultural land. When we find that in parts of Germany much the same method of correct land use as that employed in the program of the Soil Erosion Service has been used for many years, and with a high degree of effectiveness and local satisfaction, in connection with their land programs, it would appear that there should be no undue concern on the part of any patriotic citizen if this program is markedly different from anything which has ever been tried in any important way in the United States. When we find Japan, in her program of protecting valuable agricultural lands, spending many times the value of those areas occupying erosive slopes for the purpose of protecting valuable tracts of lower land from the ravages of erosion and runoff descending from above, why should we be unduly concerned if in some localities it may be found necessary to spend in some instances as much as the land is worth in order to protect it, and thereby lower-lying areas affected by it—and at the same time give protection to stream channels and reservoirs from the erosional products discharged from such critical areas?

Flood Control and Silt Prevention

When it is considered that quantitative measurements of erosion and runoff from 12 extensive and highly important types of agricultural soil scattered throughout the country show that grass and similar thick-growing crops average 65 times more effective with respect to soil conservation and cause five times as much of the rainfall to sink in the ground at or near where it falls than on the same types of soil occupying the same degree of slope and receiving the same amount of rainfall, but devoted to clean-tilled crops, no further argument should be necessary to convince any thinking person that by bringing these densely planted crops more generally into use on the more erosive areas it will be possible to bring about some close approximation of permanent flood control and a large reduction in the hazard of silting of stream channels and costly reservoirs. Conversely, it should be clear enough to any one that until this is done—until we strike at the critical points of accelerated runoff from cultivated and overgrazed slopes, from the very crests of ridges down across watersheds where floods really originate and silt loads are picked up—we shall never have any very close approximation of permanent flood control or any important reduction of the hazard of silting, within many drainage basins, at any rate. On the basis of accumulated information, it appears entirely practicable to bring about that degree of erosion control and prevention—which really means control of the runoff—over most of the crop lands of the nation and over much of the grazing lands. It appears quite possible that this work, which must be done some time regardless of the inclination of any one, would result generally in something like a 25 per cent. reduction in the volume of floods, with perhaps greater reduction in some drainage basins. If this appraisal of the possibilities of erosion control is correct, then we can in a practical way bring about adequate flood control and a tremendous reduction in the costly filling of stream channels and reservoirs.

The Path Ahead

The course that the nation must pursue if this is to be a permanently productive agricultural country seems clearly marked out. If we refuse to conserve our agricultural lands, obstinately continuing with old methods that have failed, then we may as well confess that we have consciously chosen to head straight in the direction of land disaster. Since posterity can not meet the task and since many farmers are unable to handle all phases of the work that must be done, the responsibility of the government is obvious. Aside from this responsibility, the government has a very definite and inseparable interest in the continuing welfare of its remaining areas of good agricultural land.

PRESENTATION OF PROFESSOR JULIUS ARTHUR NIEUWLAND, C.S.C., FOR THE AWARD OF THE AMERICAN INSTITUTE MEDAL[1]

By Professor MARSTON TAYLOR BOGERT
COLUMBIA UNIVERSITY

"Well, Father, now that you have taken so much trouble to show me all through your laboratories and explain so fully the conditions under which your research work is carried on, I am more than ever impressed by your splendid record of achievement!"

"Oh!" he said, in his characteristically modest way, "you overestimate what little I have been able to

[1] Hotel Astor, New York, February 7, 1935.

accomplish. It is true that we have been handicapped somewhat in our investigations by lack of needed equipment, and particularly of an adequate chemical library, but the university has done everything in its power to help me and I have been very happy in my work."

We had spent most of the day together in visiting various departments of the University of Notre Dame, giving me an opportunity of renewing old friendships, and were seated in his little private office which, like its presiding genius, was simple and unpretentious.

Born of Flemish parents in Hansbeke, Belgium, on February 14, 1878, only about nine miles along the Bruges road from Ghent, in which latter city 15 years earlier another famous Belgian chemist, Leo Hendrik Baekeland, first saw the light of day, his family emigrated to this country when he was but two years old and settled in Mishawaka, near South Bend, Indiana, where a number of his fellow Belgians were already in residence. It was natural, therefore, that in selecting his college he should have chosen the adjoining University of Notre Dame, where he received the A.B. degree in 1899 and the honorary degree of Sc.D. in 1911. In 1904, the Catholic University of America conferred a Ph.D. degree upon him.

Ordained a priest of the Roman Catholic Church in 1903, he joined the Congregation of the Holy Cross (C.S.C.), and in 1904 was appointed professor of botany at his alma mater.

This chair he filled with distinction for 14 years, acting also as curator of the botanical herbarium and of the E. L. Greene Herbarium as well as botanical librarian. During this period, he founded *The Midland Naturalist*, the first number of which appeared in April, 1909, and which later changed its name to *The American Midland Naturalist*. For 25 years he served as its editor, and contributed numerous articles to its pages, as well as to other journals. In fact, he tells me that he has already published more articles of research in botany than he will have done in chemistry if he lives a dozen years more, for he is still contributing papers in the botanical field.

One reason why his professional career began with botany, rather than with chemistry, was that when he entered the University of Notre Dame they had practically no chemical library and no funds available for the purchase of chemical journals or reference works. Books on systematic botany, however, were much less expensive and journal files not so essential. By supplying various educational institutions with microscope slides, and in other ways, he earned a little extra money which was promptly invested in botanical books, and in this way he gradually accumulated some 2,500 volumes, as well as over 20,000 plant specimens. Upon the death of his former professor of botany, the library and herbarium of the latter became the property of the university, and this added some 4,000 books and over 100,000 plant specimens to what he had already gathered, so that to-day Notre Dame still has a better botanical library than a chemical one, and botany still remains his hobby and his relaxation, for he has collected plants in nearly every state in the union. As he said to me only a short time ago: "When out in the wilds, my mind is distracted and becomes acquainted again with old plant friends. Seldom do I go into the field without finding something not only new to me but new to botanical science."

In 1918, his title was changed to professor of organic chemistry, and he has occupied that chair at Notre Dame ever since. For three years (1920–3) he was also dean of the College of Science. His chief contributions to the progress of organic chemistry have been in the field of acetylene and its derivatives, although he has published important articles in other fields as well (organic reactions with boron fluoride, lewisite, dyestuffs, hexamethylene tetramine, acetals, vulcanization accelerators, alcohols, ethers, etc.).

His first paper on acetylene appeared in 1904, in the *Journal f. Gasbeleuchtung* (Vol. 48, pp. 387–8), and was entitled "Some Reactions of Acetylene." It dealt with the electrolytic reduction of acetylene and with its chlorination. It was followed two years later by "Reactions of Acetylene with Acidified Solutions of Mercury and Silver Salts" (with J. A. Maguire) which, like practically all his subsequent chemical papers, was published in the *Journal of the American Chemical Society* (Vol. 28, pp. 1025–31, 1906).

Further studies in the chemical field were then interrupted for more than a decade by his duties and activities as professor of botany and, although he was granted a U. S. Patent (No. 1, 326, 367), under date of December 30, 1919, for a "Dye bath formed with *p*-phenylenediamine and mercury compounds," it was not until 1921 that publication in the acetylene group was resumed with his report (with R. R. Vogt) on the "Rôle of Mercury Salts in the Catalytic Transformation of Acetylene into Acetaldehyde, and a New Commercial Process for the Manufacture of Paraldehyde,"[2] followed by papers on "Acetylene Compounds with Silver Phosphate and Silver Arsenate" (with P. B. Oberdoerfer),[3] "The Preparation of Oxalic Acid from Acetylene" (with Miss Kearns and L. Heiser),[4] "The Catalytic Condensation of

[2] *Jour. Am. Chem. Soc.*, 43: 2071–81, 1921.
[3] *Jour. Am. Chem. Soc.*, 44: 837–40, 1922.
[4] *Jour. Am. Chem. Soc.*, 45: 795–9, 1923.

Acetylene with Benzene and Its Homologs" (with J. S. Reichert),[5] "The Catalytic Condensation of Acetylene with Phenols" (with H. H. Wenzke)[6] and the taking out of a Canadian patent (No. 250,295), June 2, 1925, with H. W. Matheson, for a "Synthetic resin," manufactured by passing acetylene into a phenolic substance containing sulfuric acid and a mercury salt, at a temperature of 50–150°.

In December, 1925, the American Chemical Society held, at Rochester, N. Y., its first organic chemistry symposium. One of the addresses presented on that occasion was a review by Dr. Nieuwland of his researches on acetylene and its derivatives, in the course of which he discussed, among other reactions, the formation of divinylacetylene by passing acetylene over cuprous ammonium chloride. I well recall the address and the favorable impression it made.

It happened that there was also present at the time Dr. Elmer K. Bolton, then in charge of the chemical research work of the Dyestuffs Section of E. I. du Pont de Nemours and Company, Inc., of Wilmington, Del., and now chemical director of that corporation. One of the principal initial materials for the manufacture of synthetic rubber then was a hydrocarbon known as butadiene, which was not a natural product but had to be obtained by various synthetic methods, and the corporations interested, abroad as well as here, were eagerly seeking new methods of manufacturing this raw material more cheaply. Shortly before (in 1925) this Rochester meeting, Dr. Bolton had suggested to his superiors the possibility of obtaining this butadiene from acetylene, by oxidizing the latter to diacetylene and then reducing the diacetylene, but after listening to Father Nieuwland's paper, it occurred to him that if it were practicable to make monovinylacetylene commercially from acetylene, it might offer a still more satisfactory route to butadiene and synthetic rubber. Upon discussing the problem with Dr. Nieuwland, the latter was of the opinion that it might be feasible, for he had already some evidence that the monovinyl was formed along with the divinyl derivative in the reactions he had described.

Accordingly, a group of du Pont chemists, under the able leadership of Dr. Wallace H. Carothers, began that active cooperative investigation with Dr. Nieuwland which has achieved such a brilliant success in the discovery of the new synthetic rubber substitute now marketed under the name of "Duprene."

In the course of this research, it was found that, in the presence of a suitable catalyst, hydrogen chloride could be added easily to the monovinylacetylene, with the production of a chlorobutadiene which, on standing, changed (polymerized) to an elastic mass closely resembling natural rubber, and in this way Duprene was born. Father Nieuwland's major contributions to this birth of a new industry have been the methods for the preparation of the mono- and di-vinylacetylenes, and assistance in the determination of the proper catalyst for the addition of the hydrogen chloride. Considerable embarrassment has been occasioned him by well-meaning but misinformed writers who have constantly referred to him as the inventor of Duprene. These misstatements he has done his best to correct, but they still persist and crop up every now and again in the press. It is no minifying of Father Nieuwland's work to point out that the discovery of Duprene was not made by him, but by the du Pont Company. Without his brilliant contributions to the chemistry of acetylene, however, this splendid accomplishment of the great du Pont organization could not have been realized. It was Nieuwland's pioneer work which opened the road to Duprene.

Although chemically not at all identical with natural rubber (for Duprene contains some 40 per cent. of chlorine), it bears a closer physical resemblance to it than any of the synthetic rubbers previously known. Those respects in which it differs from the natural product make it superior for some purposes and inferior for others. Its physical properties are susceptible of wide variation, depending on the character and amount of vulcanizing agent, reenforcing pigment, etc., compounded with it. It is particularly valuable in filling the need for a rubber-like material with greater resistance than natural rubber to the solvent action of gasolene, oils and other liquids, as well as to the deteriorating and disintegrating effects of heat and oxidation.

Although Duprene can not yet be manufactured at the current price of natural rubber, its selling price nevertheless imposes a limit upon that of the latter.

A little over a month ago (December 17, 1934), in the hearings at Washington before the Reciprocal Trade Agreement Committee, the Hon. Francis P. Garvan, former Alien Property Custodian and now president of the Chemical Foundation, Inc., presented a notable address, in the course of which this great benefactor of American chemistry and eloquent champion of our chemical industries had the following to say on the subject of rubber:

> We consume 65 per cent. of the world's production of rubber. In 1926, we imported 925,878,000 lbs. at an average price of 54.6¢, for which we paid $505,818,000. This year, we are roughly importing the same amount for which we will probably pay an average of 14¢ at a cost to us therefor of $130,000,000.
>
> In 1926, under the Stevenson plan (in reality an English-Dutch cartel) the price was driven as high as $1.25 a pound. In 1934 the Stevenson plan has been

[5] *Jour. Am. Chem. Soc.*, 45: 3090–1, 1923.
[6] *Jour. Am. Chem. Soc.*, 46: 177–81, 1924.

revived, but under a tighter cartel, and the only reason, as announced in the English press, that the price is not driven up to our people, as it was in 1926, is the fear of encouraging the development of Duprene. In other words, this discovery even now is possibly saving us at the rate of $375,000,000 a year.

Father Nieuwland's researches and their bearing upon the discovery of Duprene have had a peculiar fascination for me. For over 40 years, as a student of organic chemistry, I have followed the numerous attempts made in various countries to synthesize rubber on a commercial scale.

It was my good fortune to preside over the meetings of the Organic Section of the Eighth International Congress of Applied Chemistry, held in 1912 in New York and Washington, and at those meetings the rival claims of Great Britain and Germany, in the synthetic rubber field, were vigorously presented by Dr. Duisberg of Germany and the late Professor William H. Perkin of England.

Not long after these meetings, an elderly German chemist, Dr. Louis Gottschalk, applied to me for the use of space in our organic laboratories at Columbia University, to carry out experiments in this same field. He explained that he had discovered a wonderful new process and all that he needed to perfect it was laboratory space and equipment. His process, however, involved the use of steel bombs, the contents of which were heated to enormous pressures. It was explained to him that we could not undertake anything so hazardous, for if one of those bombs exploded the effect would be as devastating as the explosion of a 12-inch shell. So he organized the Alembic Process Company, with his wife, his son-in-law (George Titus) and a chemical engineer (Clifford D. Meeker) as his associates, and established a laboratory at Sewaren, N. J. On September 14th, 1913, one of these bombs let go and killed his wife instantly. Six months later, a second bomb exploded, blew Mr. Meeker and the laboratory to bits and seriously injured Mr. Titus. That was the last I ever heard of Dr. Gottschalk or his "alembic process."

The layman is familiar with the facts that acetylene is the gas commonly used for household lighting in those isolated or back-country districts where neither electricity nor the ordinary illuminating gas are available; that it was employed also in the old-fashioned automobile headlights; and that its chief service today is in oxy-acetylene torches for cutting and welding. He may know also that this gas is generated by the action of water upon calcium carbide and that the carbide is manufactured by heating in an electric furnace a mixture of lime and carbon; but that is usually as far as his information extends.

To the chemist, however, acetylene is of transcendent interest, because it is in many respects the most fundamental and most valuable building unit for the whole vast structure of synthetic organic chemistry, for Berthelot showed, more than 70 years ago (January, 1863), that acetylene could be prepared by passing an electric arc between carbon poles in an atmosphere of hydrogen; in other words, that acetylene could be produced from the elements carbon and hydrogen themselves; and this gas is a highly unsaturated compound, which unites so avidly with certain elements that violent explosions ensue. In the presence of suitable catalysts, and when no other substance is at hand, it will unite with itself, that is to say its constituent molecules combine to larger aggregates, "polymerize," as the chemist calls it, and in this way mono- and divinyl-acetylenes are formed.

It is no exaggeration to say that hundreds of thousands of carbon compounds can be built up step by step from acetylene, for it is not only the foundation of what is known as aliphatic chemistry but of aromatic chemistry as well, both isocyclic and heterocyclic. Products of vital functions, indispensable drugs, dyestuffs, perfumes, plastics and an innumerable host of other useful compounds can be obtained from this remarkable hydrocarbon.

Is it any wonder, then, that Father Nieuwland should have elected to study more closely its chemistry, even though he realized that such experiments were fraught with some peril to the experimenter? In the course of his work he has, of course, had some explosions, but fortunately without any tragic results, and he has finally tamed these dangerous forces so that now, when he addresses them sternly, they reply obediently, "Yes, Father!"

Unlike certain governmental officials who are so successful in making two lemons grow where only one grew before and then handing them both to you when you are not looking, Father Nieuwland has really made new compounds grow and blossom where none were known before and by his discoveries has contributed to the founding of a new and most promising industry.

Many of the facts he utilized in this achievement had lain buried in the literature for decades, waiting patiently for the arrival of that master who should fit them into their proper places in some worthwhile plan for the progress of science and industry.

Professor Nieuwland is a member of many scientific societies both here and abroad, and has been the recipient of numerous honors.

He was president of the Indiana Academy of Science during its Jubilee year (1934). In 1933, he received the John Motley Morehead Medal of the

National Acetylene Association and has just recently been awarded the William H. Nichols Medal of the American Chemical Society, "for basic work on syntheses from unsaturated hydrocarbons." The ceremony at which this latter medal will be presented to Father Nieuwland is planned to be one of the outstanding features of the celebration of the tercentenary of the founding of the American chemical industries, to be held in this city during the week of April 22, in connection with the eighty-ninth meeting of the American Chemical Society.

Modest, unassuming, a most delightful companion and lovable personality, to know him is to become immediately his warm friend and admirer.

Mr. President, I now have the honor to present Julius Arthur Nieuwland, eminent chemist and botanist, for the award of the Gold Medal of the American Institute. In the citation of our Council on Awards, this distinction is recommended "for a life-time of patient research devoted to new fields of organic synthesis based on acetylene, to which he has made notable contributions."

OBITUARY

HERDMAN FITZGERALD CLELAND

HERDMAN FITZGERALD CLELAND, Edward Brust professor of geology and mineralogy at Williams College, was born at Milan, Illinois, July 13, 1869, the son of David J. and Margaret (Betty) Cleland. He met a tragic death in the *Mohawk* disaster on January 24, 1935, while en route to Yucatan with a party of young men whom he was to guide in the study of the Mayan remains. Three of the students, all seniors at Williams, shared his fate.

Cleland was of Scotch and Irish ancestry. His grandfather, Samuel Cleland, was a graduate of the University of Glasgow and of the Theological School at Belfast College. He came to the United States in 1826, and was pastor of various Presbyterian churches in Ohio, Iowa and Illinois till his death in 1865. Cleland's maternal grandfather, John Betty, came to this country from Ireland in 1842 and was engaged in various commercial enterprises. Herdman inherited a tradition of culture, refinement and scholarship. His thrifty Scotch training was a lifelong advantage. He lived simply but well, always managing to set aside something to be used in helping others. President Tyler Dennett has said of him: "He was also generous, one of the most generous citizens of Williamstown, not in ostentatious ways, but quietly and simply as he lived. I am told that there is more than one family in our village, which, due to his help, now owns the roof over their heads. There are others, many of them, who learned that when in sore need they could find both sympathy and substantial help. A model teacher, he was in equal degree a model citizen."

His last reported words, "I'm sorry the trip is off, boys, but I wish they had waited till the water was warm before they threw us in," show that he faced the end with the same calm courage and dry humor that had carried him through other crises in his life. Although quiet and reserved, he had an infinite capacity for making friends, to whom his conversation was a delight. He was fastidious, physically and mentally, and was annoyed by much which he saw and read; but his criticisms generally emerged as witty remarks which did not sting; yet were so pointed that they often produced good results. He was forthright and frank, yet withal so just that he aroused no personal antagonism. The mass production of the lecture system did not appeal to him. He was profoundly interested in each of his students, ever ready with counsel, advice and stimulation. That his students were well trained is attested by the records of the geologists who have graduated from Williams during the last thirty-three years. His instruction and his personality equally influenced a majority of his students who did not become professional geologists.

Cleland's early education was greatly delayed by the inadequacy of the schools in the small frontier town in which he passed his earlier years. He received a part of his preparatory training, and took two years of undergraduate work, at Gates College in Nebraska, but received his A.B. at Oberlin in 1894, where his interest in geology was fostered by the late Professor Alfred A. Wright. After graduation, ill health forced him to return for a year to the home of his father at Pierce, Nebraska. He attended the summer session of the University of Nebraska in 1895, and that fall entered upon the duties of professor of natural sciences at Gates College, where he remained three years. A summer at the University of Chicago in 1896 crystallized his leanings toward geology, and, realizing the difficulty of teaching all the natural sciences, he gave up his position at Gates College in 1898. That autumn he entered the graduate school at Yale, studying chiefly under Henry Shaler Williams, then the outstanding exponent of stratigraphic paleontology. He received his degree of doctor of philosophy there in June, 1900.

Being at a loose end, he that summer joined the first of the notable peripatetic summer schools con-

ducted by Professor Harris of Cornell. This company, which included professors, doctors of philosophy, graduate students, school teachers and a few advanced undergraduates concentrating in geology, was admirably adapted for mutual instruction. It was particularly inspiring to the present writer, whose previous contact with geology had been confined to the reading of such out-of-date text-books as were to be found in a small-town library. That ten weeks was the equivalent of the ordinary undergraduate training in the subject, for there were no soon-forgotten lectures. Everything which was said applied to objects before the eyes of the party at the moment. Thus we were taught not only to reason backward from result to cause, but, through the multiplicity of teachers, were made to realize that most phenomena have more than one plausible explanation.

The writer owes much to all members of that party, but most to Cleland, for despite the fact that he was denominated Doctor, and that I was a prospective junior turning to geology after two years in the College of Engineering, he undertook the task of seeing that I understood the results of every discussion. He was always ready to answer questions, and, best of all, he was equally ready to admit that certain questions could not be answered by him or had as yet no answers. No greater stimulus for further study or original research is possible.

Cleland spent the ensuing year at Cornell, engaged in research and teaching. During Professor Harris's absence in the winter term, which he then devoted to his duties as state geologist of Louisiana, Cleland gave the courses, one of which was devoted to a detailed discussion of the fossil Brachiopoda.

In the autumn of 1901, he was called to Williams College, where he was instructor in geology and botany till 1904, assistant professor till 1907, when he became professor of geology and mineralogy. After teaching all the sciences, he was at last in a position to teach one. Even so his task was not simple. He had to build up a department and a museum. He succeeded in doing both.

Cleland's early researches were in the realms of paleontology and stratigraphy. His doctoral dissertation, published as a Bulletin of the U. S. Geological Survey, was a very detailed study of the distribution of the fossils in the Hamilton formations exposed along Cayuga Lake. He later described the fauna of the Mid-Devonian strata at Milwaukee, Wisconsin, and also published two important papers descriptive of the Beekmantown fossils of the Mohawk Valley. He subsequently withdrew almost entirely from this field, devoting himself to his first text-book, "Physical and Historical Geology" (American Book Company, New York, 1916), and to other geological subjects, particularly the origin of natural bridges. His "Practical Applications of Geology and Physiography" (Excelsior Press, North Adams) appeared in 1920.

Later in his life his interests changed again. Numerous trips to Europe, some of them prolonged, brought him in contact with the vestiges of prehistoric civilizations. He took up particularly the study of the Neolithic and later ages, a part of the story of ancient man commonly considered to be outside the province of the geologist. This led to his interesting book, "Our Prehistoric Ancestors" (Coward-McCann, Inc., New York, 1928). His last work was a little volume entitled, "Why be an Evolutionist?", 1930.

Cleland was a fellow of the American Association for the Advancement of Science, American Academy of Arts and Sciences, Geological Society of America (councilor, 1928–31), Paleontological Society (secretary, 1909), American Geographical Society, member Seismological Society, American Institute of Mining and Metallurgical Engineers, American Archeological Society, New York Academy of Science, Phi Gamma Delta, Sigma Xi and Phi Beta Kappa (honorary member).

He was married twice, first to Helen Williams Davison, and, after her death, to Emily Leonard Wadsworth. His widow, four daughters, a brother and a twin sister, Elizabeth, who has ever been his help in time of trouble, survive him.

A man of high ideals, broad culture, wide interests and an unusual personality has suddenly been taken from us. A host of former students and colleagues mourn him.

PERCY E. RAYMOND

RECENT DEATHS

PROFESSOR WILLIAM JOHN SINCLAIR, for thirty years a member of the department of geology of Princeton University, died on March 25. He was fifty-seven years old.

SIR EDWARD SHARPEY-SCHAFER, professor emeritus of physiology at the University of Edinburgh, died on March 29 at the age of eighty-four years. The council of the University of Edinburgh had approved on March 19 the establishment of a Sharpey-Schafer Lectureship in physiology, a fund for its endowment having been contributed by his pupils and friends.

AKIRA FUJINAMI, professor emeritus of the Kyoto Imperial University, died on November 18, 1934. To workers in cancer research the late Professor Fujinami is known for his first discovery of a transplantable chicken sarcoma and for his work on a neoplasm of this type.

SCIENTIFIC EVENTS

THE ANNUAL REPORT OF THE DIRECTOR OF THE FIELD MUSEUM OF NATURAL HISTORY

THE annual report of Stephen C. Simms, director of the Field Museum of Natural History, has been issued. The continued financial difficulties which confront the museum as a result of depression are emphasized in Mr. Simms's introductory remarks to a description of the work carried out in 1934. He writes:

The budget adopted was again substantially reduced, and no expeditions or purchases of collections were provided for except where made possible by contributions for specific new research during the year. As anticipated, income from endowments and tax collections was less than in 1933; income from contributions was very much smaller; and, while the downward trend in income from memberships was greatly retarded, there was nevertheless a reduction of receipts from that source. Revenues from admissions and sundry receipts, which in 1933 were far above average, decreased in 1934 as a natural result of the smaller number of visitors, especially those from out of town, to the Century of Progress exposition in its second year. By rigid economies the museum succeeded in keeping actual expenditures well within budget appropriations and was enabled without reduction in salaries or personnel to cover its essential operating expenses, and to reduce notes payable caused by previous years' deficits from $105,000 to $95,000.

Donations of funds received by the museum in 1934 include gifts from Marshall Field, of New York and Chicago, of $26,140; from Mrs. Oscar Straus, of New York, of $11,105, and from Mrs. James Nelson Raymond, Chicago, of $4,000. A bequest of $100,000, subject to the life interest of Frederick R. Babcock, is provided in the will of the late Mrs. Abby K. Babcock. Income of $2,500 was received from a bequest of the late Mrs. Augusta N. Rosenwald. Large amounts of material for addition to the exhibition and reference collections, and for the library, were received from friends of the museum.

On the museum's attendance in 1934, Mr. Simms reports in part as follows:

Insofar as those activities directly connected with serving the public are concerned, the museum, despite the severe economies which had to be instituted, managed to maintain its customary standards. The number of visitors at the museum was 1,991,469, which, while it represents a large decline from the attendance of 3,269,390 recorded in 1933, was nevertheless the second highest year's attendance in the history of the institution. The decline from the 1933 peak was a natural and expected consequence of the smaller attendance experienced by A Century of Progress.

Taking into consideration extra-mural activities, the museum's educational influence was carried directly to a total of more than 2,650,000 persons during 1934. This figure includes the visitors received in the building itself, together with approximately 662,000 persons (chiefly children) reached by the outside work conducted by the institution through the James Nelson and Anna Louise Raymond Foundation for Public School and Children's Lectures, and the Department of the N. W. Harris Public School Extension. Only 99,553 persons, or approximately 5 per cent. of the total attendance, paid the 25-cent admission fee.

Lectures in the schools and motion picture programs at the museum, provided by the Raymond Foundation, reached 213,579 children. The traveling natural history exhibits of the Harris Extension were circulated to more than 400 schools where approximately 500,000 children saw them daily.

The report contains detailed accounts of the many new exhibits added during the year, of research conducted by the departments of anthropology, botany, geology and zoology, of the several expeditions which were made possible by special contributions and of all other activities of the museum.

SOIL EROSION CONTROL

To unify all soil erosion control activities of the federal government, Secretary of Agriculture Henry A. Wallace has issued an order establishing a separate soil erosion unit in the Department of Agriculture. Under Secretary R. G. Tugwell has undertaken the task of consolidating the various departmental units working in this field. The base of the new organization will be the Soil Erosion Service, which has just been transferred to the Department of Agriculture from the Department of the Interior; this transfer was authorized by the Public Works Board at the request of the President.

All investigational, service and control projects on erosion, heretofore under the supervision of the Bureaus of Chemistry and Soils, Agricultural Engineering and Plant Industry and the supervision of CCC erosion-control work now under direction of the Forest Service, were transferred on April 1 to the new unit.

H. H. Bennett will head the consolidated activities. Mr. Bennett has been in charge of the Soil Erosion Service since it was organized, and previously was in charge of soil erosion investigations of the Bureau of Chemistry and Soils.

Research into the soil, plant and engineering aspects of the cause and methods of controlling erosion will continue to be conducted at ten field stations. Using the facts developed by this research, large-scale demonstrations will be continued in various parts of the country.

The recent dust storms, as well as the severe dust storm of May, 1934, forcibly called the attention of city and country people to the seriousness of wind

erosion. Water erosion, of course, is much more widespread and destructive because it is a continuous process in many parts of the country. More than 50 million acres of land in the United States has been destroyed for crop production by erosion. Another 125,000,000 acres of land new in crops has lost all or most of its topsoil. About 100,000,000 acres is rapidly approaching that condition. At least three fourths of the farm land of the United States used for clean-tilled crops is subject in varying degrees to erosion, the damage from which to farm lands, roads, reservoirs, irrigation ditches and valley lands is estimated at more than $400,000,000 a year. Studies in Oklahoma show that cultivated fields lost 84 per cent. more rainfall and 667 times more soil than similar fields that were under a grass sod.

The Bureau of Agricultural Engineering has studied control of erosion by artificial structures such as terraces, tile drains, check dams and soil-saving dams. The field research of the Bureau of Chemistry and Soils and Agricultural Engineering has been conducted at field stations at Bethany, Mo.; Guthrie, Okla.; Hays, Kans.; LaCrosse, Wis.; Clarinda, Iowa; Pullman, Wash.; Statesville, N. C.; Temple, Tex.; Tyler, Tex., and Zanesville, Ohio. The Bureau of Plant Industry, in addition to introducing and selecting plants best suited for use in soil erosion control work, recently established large-scale soil erosion nurseries on which will be grown various plants for use in control projects. These nurseries have been financed with emergency funds.

Research primarily discovers how erosion may be controlled most effectively and economically. These results are translated into action by farmers themselves and by the Soil Erosion Service which is demonstrating effective methods of land conservation in forty erosion control projects in 32 states. Ranging in size from 50,000 to 16,000,000 acres each, these projects cover representative watersheds in the major agricultural sections where erosion has become a critical problem.

THE ANNUAL MEETING OF THE AMERICAN PUBLIC HEALTH ASSOCIATION

THE sixty-fourth annual meeting of the American Public Health Association will be held in Milwaukee, from October 7 to 10. The society has a membership of 4,500 professional public health workers whose annual sessions review developments in health protection and promotion and outline plans and policies for future advances.

Several related organizations have announced that they will meet simultaneously with the association at Milwaukee. They are: American Association of School Physicians, International Association of Dairy and Milk Inspectors, Conference of State Sanitary Engineers, International Society of Medical Officers of Health, Association of Dairy, Food and Drug Officials, Conference of Wisconsin Health Officers, Conference of State Laboratory Directors and Association of Women in Public Health.

The fourth Health Education Institute sponsored and conducted by the association will be held on October 4, 5 and 6, prior to the opening of the several conventions. The subject will be "Health Education in Small Cities and Rural Communities."

A Health Exhibit including in its scope commercial, scientific and educational displays will be conducted as usual at Milwaukee.

Plans for the preliminary program include special sessions on The Rôle of a Health Department in a Program of Social Security, Mental Hygiene, Professional Education, Veterinary Public Health, Diphtheria Immunization, and a session on the history and achievements of the Committee on Administrative Practise, celebrating its fifteenth anniversary.

The association is divided into ten sections—Health Officers, Laboratory, Vital Statistics, Public Health Engineering, Industrial Hygiene, Food and Nutrition, Child Hygiene, Public Health Education, Public Health Nursing, Epidemiology. Subjects to be discussed include pneumonia, trench mouth, syphilis, measles, outdoor bathing places, scarlet fever, milk sanitation, water sanitation, foods, health education, and many other topics representing the responsibilities of health authorities.

The chairman of the Local Committee on Arrangements is Dr. John P. Koehler, Health Officer of Milwaukee. Information in regard to the congress can be obtained from the American Public Health Association at 50 West 50th Street, New York City.

THE LOS ANGELES MEETING OF THE PACIFIC DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

A PRELIMINARY announcement of the forthcoming meeting of the Pacific Division, to be held at the University of California at Los Angeles during the week of June 24, 1935, will be distributed to members early in April.

Two of the principal addresses to be presented during the meeting will be given by Professor Bailey Willis, president of the Pacific Division, and Fred. E. Wright, of the Geophysical Laboratory, Washington, D. C. The subject of Professor Willis's address will be "The Living Globe," while that by Mr. Wright will be on "The Surface of the Moon."

The meetings will open formally on the morning of Tuesday, June 25, with a general symposium on "The

Earthquake Situation." The following topics will be discussed:

"Historically Recorded Earthquakes in California": Owen C. Coy, University of Southern California, Los Angeles.

"Seismologic Research":

(a) Earthquakes of Northern California, Perry Byerly, University of California, Berkeley.

(b) Research on Near and Far Earthquakes, B. Gutenberg, California Institute of Technology, Pasadena.

(c) Vibration Research for Earthquake-resistant Buildings, L. Jacobsen, Stanford University.

(d) Development of the U. S. Coast and Geodetic Survey Seismological Program in California, T. J. Maher, U. S. Coast and Geodetic Survey, San Francisco.

"Mechanics of Earthquake Activity": Bailey Willis, Stanford University.

"The Construction of Earthquake-resistant Buildings": Geo. B. McDougall, state architect, Sacramento.

The afternoon of Tuesday, June 25, will be devoted to a series of reviews on the progress of research in selected fields of general interest. Attention will be centered upon a few of the most noteworthy achievements described in relation to outstanding developments and problems of commanding interest in the fields at large. The reviews will be presented as follows:

"Recent Developments in Acoustics": V. O. Knudsen, University of California at Los Angeles.

"The Mechanism of Heredity": Th. Dobzhansky, California Institute of Technology.

"Recent Developments in the Field of Hormones": B. M. Allen, University of California at Los Angeles.

On the morning of Wednesday, June 26, a symposium on "The Virus Diseases of Plants and Animals" will be held under the auspices of the American Phytopathological Society, Pacific Division; Botanical Society of America, Pacific Section; Society for Experimental Biology and Medicine, and the Western Society of Naturalists.

The remainder of the week will be given over to the programs of participating societies of which seventeen or eighteen will be joining in the meeting.

Members proposing to present papers are reminded that titles received after May 1 will be too late for publication in the program. This will be distributed during the last week of May to all members of the association resident in the territory of the Pacific Division.

Many excursions of considerable interest are being arranged and will be described in full in the program.

J. MURRAY LUCK,
Secretary

SCIENTIFIC NOTES AND NEWS

ON the occasion of his eighty-second birthday on March 29 Professor Elihu Thomson was presented with the medal of honor of the German Society of Engineers. The presentation was made at a luncheon of the board of directors of the General Electric Company. Among those present were Owen D. Young, Gerard Swope, Philip Stockton, Charles F. Adams and Francis Lee Higginson. Because of Professor Thomson's ill health Edwin W. Rice, Jr., accepted the medal, which was presented by Kurt von Tippleskirch, German consul in Boston. As translated the inscription on the medal reads: "On Elihu Thomson, the great pioneer in the realm of engineering, the inventor and scientist, the promoter of cooperation among engineers, there is conferred on his eighty-second birthday the V. D. I. medal of honor."

THE Kelvin Gold Medal for 1935, awarded triennially as a mark of distinction in engineering work or investigation of the kinds with which Lord Kelvin was especially identified, has been conferred on Sir John Ambrose Fleming, in recognition of his services to electrical science and particularly of his invention of the thermionic valve. The presentation ceremony is expected to take place at a meeting of the British Institution of Civil Engineers early in May.

DR. IRVING LANGMUIR, of the General Electric Company, and Professor Harold C. Urey, of Columbia University, will be the guests of honor at a dinner on Monday evening, April 22, one of the opening events of the tercentenary celebration by the American Chemical Society of the founding of the nation's chemical industries. The dinner will be given by the Division of Physical and Inorganic Chemistry. Professor Victor K. LaMer, of Columbia University, will preside.

A PORTRAIT of Dr. Martha Tracy, dean of the Woman's Medical College of Pennsylvania, was presented to the college on its eighty-fifth anniversary on March 9. This is Dr. Tracy's twenty-fifth year at the college. Dr. Ellen C. Potter, Trenton, N. J., made the presentation. Dr. Helen Ingleby, professor of pathology, on behalf of trustees, faculty, students and friends, presented an automobile to Dr. Tracy.

THE Cross of the Legion of Honor was conferred on March 26 by Consul General Charles de Font-

nouvelle of France upon David Sarnoff, president of the Radio Corporation of America, "in recognition of his pioneering and great accomplishments in the science of radio." The presentation took place in the Consulate General in La Maison Française, of the Rockefeller Center, New York City.

M. CHARLES POISSON has been elected correspondent of the Paris Academy of Sciences in the place of the late William Morris Davis.

DR. HAROLD ST. JOHN, professor of botany at the University of Hawaii, has been elected a corresponding member of the Czechoslovakian Botanical Society.

PROFESSOR W. N. HAWORTH, director of the department of chemistry of the University of Birmingham, has been elected a corresponding member of the Bavarian Academy of Sciences.

THE Bessemer Gold Medal for 1935 of the British Iron and Steel Institute has been awarded to Professor A. M. Portevin, of Paris.

THE Duddell Medal has been awarded by the Physical Society, London, to Dr. W. Ewart Williams, of King's College, London, for his work in optical design in the field of interferometry.

AN award of $10,000 has been made to Miss Lillian Banks, of Norfolk, Va., whose design has been accepted for the "universal memorial light" to Thomas Alva Edison.

DR. THOMAS S. FISKE, since 1897 professor of mathematics at Columbia University, will retire at the end of the academic year with the title emeritus professor. Dr. Fiske received the degree of A.B. from Columbia in 1885 and since then has been continuously connected with the university. Since 1901 he has been secretary of the College Entrance Examination Board. He was from 1902 to 1904 president of the American Mathematical Society, of which he had been secretary and editor of the *Bulletin* and *Transactions*.

PROFESSOR KARL S. LASHLEY, now at the University of Chicago, has accepted an appointment as professor of psychology at Harvard University.

DR. DAVID A. TUCKER, JR., associate clinical professor of contagious diseases at the University of Cincinnati College of Medicine, has been appointed professor of the history of medicine.

DR. J. H. SIMONS, secretary of Section C of the American Association for the Advancement of Science, has been appointed associate professor of physical chemistry at Pennsylvania State College.

DR. JOSEPH TANNENBERG, professor of pathology at the University of Frankfurt, has arrived in Albany to assume for one year the post of director of Bender Hygienic Laboratory. He succeeds Dr. Arthur W. Wright, now professor of pathology and bacteriology at the Albany Medical College.

DR. ETHEL C. DUNHAM, associate clinical professor of pediatrics at the Yale University School of Medicine, has been named acting director of the division of maternal and child health, U. S. Children's Bureau. Dr. Dunham graduated from the Johns Hopkins University School of Medicine in 1918.

DR. JULES BLACHE, professor of geography in the University of Grenoble, is the exchange professor from France at Harvard University during the current half year. While here he is offering one regular course on the "Geography of Mountains" and giving a series of eleven public lectures on the general heading of "Geography of French Agriculture."

AN Institute of Experimental Surgery has recently been inaugurated at the Medical Faculty of Buenos Aires, under the direction of Dr. Guillermo Bosch-Ayana, professor of operative medicine.

THE R. A. F. Penrose, Jr., memorial lecture of the American Philosophical Society will be delivered on April 18 by Dr. W. F. G. Swann, director of the Bartol Research Foundation of the Franklin Institute, Philadelphia. He will speak on "The Second Law of Thermodynamics."

THE Edgar Marburg Lecture of the American Society for Testing Materials will be delivered at the annual meeting to be held in Detroit from June 24 to 28 by Dr. L. B. Tuckerman, chief of the Division of Mechanics and Sound of the National Bureau of Standards. The lecture will be on the general field of the development and application of materials in the aircraft industry.

THE fifth Joseph Henry Lecture of the Philosophical Society of Washington was delivered on March 30 by Dr. Paul R. Heyl, of the National Bureau of Standards. The title of the lecture was "What is Electricity?"

DR. GLEB V. ANREP, professor of physiology at the Egyptian University at Cairo, delivered the Edward Gamaliel Janeway Lectures at Mount Sinai Hospital, New York City, on March 25 and 26. His subjects were "The Duodenopyloric Mechanism in Relation to the Sympathetic Nervous System" and "The Coronary Blood Flow in Relation to Pulse Pressure." Dr. Anrep will give the Lane Medical lectures at Stanford University from April 22 to 26.

DR. C. C. LITTLE gave the annual initiation address to the Brown University Chapter of Sigma Xi on March 21 on "Some Recent Advances in Cancer Research." He also spoke informally at the Faculty Club luncheon on "Birth Control and its Social Implications."

DR. T. WINGATE TODD, professor of anatomy at the School of Medicine of Western Reserve University, Cleveland, spoke on March 18 before the Thomas P. Hinman Mid-Winter Clinic at Atlanta, Ga., on "The Physical Constitution of the Growing Child." He also made an address at the University of Georgia on "Negro Child Development."

DR. WILLIAM W. CORT, professor of helminthology at the Johns Hopkins University School of Hygiene and Public Health, will deliver the Gehrmann lectures of the University of Illinois College of Medicine, from April 8 to 10. The titles of the three lectures are: "Studies on Ascariasis in Children in the United States"; "Epidemiology and Control of Schistosomiasis (Bilharziasis) in Egypt," and "Present Status of the Hookworm Problem in the United States."

PROFESSOR J. B. S. HALDANE delivered at the University College of Swansea on March 13, 14 and 15 a course of three public lectures on "Human Heredity."

THE American Institute of Nutrition will meet at Detroit on April 10.

THE Wisconsin Academy of Sciences, Arts and Letters will hold its sixty-fifth annual meeting on April 12 and 13 in Beloit as guests of Beloit College. The Wisconsin section of the American Chemical Society will meet with the academy on April 13 for the presentation of a program of fourteen papers.

THE Mobile Academy of Science was organized by a group of some twenty-five teachers of science, physicians and others interested in the subject living in and around the city of Mobile, on Wednesday, March 27. The following officers were elected: *President,* the Rev. Dr. P. H. Yancey, S.J., professor of biology at Spring Hill College; *Vice-president,* Dr. Toulmin Gaines, dermatologist of Mobile; *Secretary,* Matt Lawler, physics teacher in Murphy High School, Mobile. The academy will meet once a month to hear scientific papers by the members or invited speakers and will also undertake field trips for the study of geology, archeology, botany and zoology.

THE meetings of the Georgia Academy of Science, the Southeastern Section of the Mathematical Association of America, the Georgia Section of the American Chemical Society, and the initial meeting of the Southern Section of the American Physical Society held at Agnes Scott College, Decatur, Georgia (except the Saturday session of the Physical Society, at Emory University), March 22 and 23, had an attendance of over four hundred. This perhaps represents the largest group ever to convene in Georgia. Sixty-eight papers dealing with research work of the members were read. The following additional papers were given by guest speakers: "Cosmic Rays on Seven Continents," A. H. Compton, University of Chicago (Agnes Scott Lecture Association); "Glass, an Indispensable Factor in Modern Civilization," Alexander Silverman, University of Pittsburgh (Georgia Academy of Science and the Georgia Section of the American Chemical Society); and "Movement of Mercury's Perihelion" and "The Place of Mathematics in Secondary Education," K. P. Williams, Indiana University (Southeastern Section of the Mathematical Association of America).

THE Science Forum of the New York Electrical Society presented on March 27 a symposium entitled "Scientific Education—What is Wrong with It?" The speakers were Dr. Harry Woodburn Chase, chancellor of New York University; Dr. William E. Wickenden, president of the Case School of Applied Science, Cleveland; Dr. Colin G. Fink, head of the division of electrochemistry, Columbia University, and Dr. Alan Gregg, director of the division of the medical sciences at the Rockefeller Foundation.

A DINNER celebrating the hundredth anniversary of the birth of Alfred Nobel will be held in the Grand Ballroom of the Waldorf-Astoria on April 9. It has been decided to make of this an annual event, with Nobel laureates of the current year as the guests of honor. Drs. George R. Minot, William P. Murphy, H. C. Urey and G. H. Whipple have indicated their intention to be present and all others who have in previous years received a Nobel prize have been invited to attend. Dr. Foster Kennedy will act as toastmaster and other guests of honor and speakers will include: Dr. Alan M. Chesney, dean of the Medical School of the Johns Hopkins University; Dr. David L. Edsall, dean of Harvard Medical School; Dr. Willard C. Rappleye, dean of the College of Physicians and Surgeons, Columbia University, and Dr. M. Charles Winternitz, retiring dean of the Medical School of Yale University.

A TWO-DAY conference of the advisory council of the Milbank Memorial Fund was held on March 29 and 30 at the New York Academy of Medicine, at which questions of tuberculosis control, population problems, health education and other allied subjects were discussed at round-table meetings. Among the speakers at the annual dinner of the Board of Directors were Miss Josephine Roche, assistant secretary of the treasury; Dr. Hugh S. Cumming, surgeon-general, the United States Public Health Service; Dr. Livingston Farrand, president of Cornell University; Dr. Simon Flexner, director of the Rockefeller Institute for Medical Research, and Albert G. Milbank, president of the fund. Others who took part in the con-

ference were Dr. E. R. Baldwin, director of the Trudeau Foundation, Saranac; Dr. Robert L. Dickinson, secretary of the National Committee on Maternal Health; Dr. Louis I. Dublin, third vice-president of the Metropolitan Life Insurance Company; Professor Henry Pratt Fairchild, of New York University; Homer Folks, secretary of the State Charities Aid Association, and Dr. John A. Hartwell, director of the New York Academy of Medicine.

SIGMA PI SIGMA, honorary physics society, installed its twenty-ninth chapter at the Michigan State College on March 2 when the charter was presented to a group of thirty-nine students and faculty members by Dr. Marsh W. White, executive secretary. Dr. Robert H. Spahr, director of instruction and curricula at the General Motors Institute, Flint, Mich., and Dr. R. W. Smith, research associate at the University of Michigan, assisted the installing officer in inducting the petitioning group as the Alpha-Epsilon chapter of the society. Dr. E. F. Barker, professor of physics at the University of Michigan, was initiated as an honorary member of the society and, after the installation banquet, gave an address on "The Modern Alchemist" at the first open meeting of the chapter.

LECTURES at the New York Botanical Garden, to be held on successive Saturday afternoons at 3:30 o'clock from March 30 to April 23, are as follows: "Molds and Mushrooms that Cause Human Ills," Dr. J. Gardner Hopkins, College of Physicians and Surgeons, Columbia University, and Dr. B. O. Dodge, plant pathologist; "South African Flowers and Scenery," Mrs. Jerome W. Coombs, Federated Garden Clubs of New York State; "Annuals for the Garden," T. H. Everett, horticulturist; "Summer-flowering Bulbs," Dr. Forman T. McLean, supervisor of public education; "Spring Wild Flowers," Dr. John Hendley Barnhart, bibliographer and administrative assistant; "The New York Botanical Garden: Its History and Its Work," Dr. Marshall A. Howe, assistant director; "Lilies for Gardens," Dr. A. B. Stout, director of the laboratories; "The Flora of the Watchung Mountains," Dr. Harold N. Moldenke, assistant curator; "The First Families of Florida and their Crops," Dr. H. Beaman Douglass, physician.

WE are informed through the courtesy of the general secretary of the International Committee of Annual Tables of Constants, M. Ch. Marie, Paris, that the Academy of Sciences of the U. R. S. S. has signed an agreement with the committee, guaranteeing for the coming five years a contribution to the international fund for the publication of Annual Tables of Constants. In exchange the academy will receive a certain number of volumes edited by the committee. These volumes will be distributed among the universities and scientific institutions of the Soviet Union. Similar agreements have been already signed with the French Government, the Helvetic Government and the Polish Academy of Sciences.

THE Johns Hopkins University School of Medicine has received an additional gift of $150,000 from the estate of Joseph Raphael DeLamar, who died in 1918. The *Journal* of the American Medical Association reports that a fund of $4,706,450, which has been paid to the medical school over a period of years under Mr. DeLamar's will, supports many activities, including the DeLamar Lectures in Hygiene at the Johns Hopkins University School of Hygiene and Public Health. The will provided that, after other bequests had been made, the residue was to be divided so that one third went to the medical school and another third to the College of Physicians and Surgeons of Columbia University. This is the authorization for the recent gift. The DeLamar Lectures were established "to give to the people of the United States generally the benefits of increased knowledge concerning the prevention of sickness and disease and also concerning the conservation of health by proper food and diet."

THE estate of Mrs. T. Coleman du Pont, at Irvington-on-Hudson, has been given to Columbia University. The property consists of sixty-eight acres, on which there is a mansion, and probably will be used in studies of landscape architecture conducted by the Columbia School of Architecture. The estate extends from the Albany Post Road to the Hudson River and now has four acres in flowers. Mrs. du Pont made the gift in memory of her husband. With the estate will go a fund sufficient for maintenance for three years.

THE University of Michigan has been granted a fourth of the estate of the late Bernard C. Hesse, the New York chemist, valued at $123,073. Dr. Hesse graduated from the university in 1893.

ACCORDING to the *Journal* of the American Medical Association, continuance of a dental research project in Yale University School of Medicine has been made possible through a grant of $17,500 by the Carnegie Corporation of New York. This program, instituted in July, 1929, under a grant of the Rockefeller Foundation, is an intensive study of the teeth in relation to the body in general by physicians, radiologists, bacteriologists, pathologists and dentists. The original study group included Dr. Milton C. Winternitz, Dr. Samuel C. Harvey, the late Dr. William A. LaField, Dr. Félix d'Herelle, Dr. George H. Smith, Dr. Raymond G. Hussey and Dr. William Downs, Jr.

DISCUSSION

THE NEBRASKA EARTHQUAKE OF MARCH 1, 1935

RESIDENTS within an area of 50,000 to 75,000 square miles in Nebraska, Iowa, Missouri and Kansas were awakened by mild but distinct earth tremors at 5:00 and 5:03 A.M. on March 1. No damage of any importance has been reported. Two distinct tremors occurred, each lasting about 10 seconds, about 3 minutes apart.

In a few cases vases or other small objects were shaken off from small unsteady tables. The writer was awakened by the second tremor. The vibrations seemed to oscillate in an east-west direction. The bed vibrated in this direction and the spring was tapping the footboard when the writer awakened. The mirrors of a high vanity dresser standing against the east wall of the room were also loudly clattering against the wall.

The writer also noted a very distinct rumbling accompanying the tremors. It greatly resembled the rumble of a heavy freight train. Many other persons also noted the rumble, and some have stated that the rumble preceded the actual tremors by a few seconds. The writer at first thought that the rumble might be that of a train, but it ceased immediately when the tremors stopped. This was noted at the time. Subsequently, other persons have reported the rumble from country homes too remote from trains or street traffic to leave any room for doubt of its connection with the earthquake.

The rumble was so distinct that the writer feels it should be specially noted. Since the mechanical vibrations which constitute the tremors may be and commonly are of audio-frequency, sound is a natural accompaniment of an earthquake. However, the sound vibrations set up by earth tremors are frequently masked by other noises and the commotion that often accompanies such events. The quiet of the morning hour and the mildness of the tremors, unaccompanied by the noise of crumbling masonry, *et cetera,* makes the record of the rumbling in the Lincoln, Nebraska, area of considerable interest.

The record sheets of the automatic pressure recorders for the 28-mile pipeline from Ashland to Lincoln, Nebraska, which supplies water from the city of Lincoln, indicated abnormal and peculiar pressure variations during the earthquake.

As far as known, the greatest intensity seems to have been noted at Falls City, Lincoln and to a less degree at Omaha, Nebraska, and at St. Joseph, Missouri.

The writer is in complete agreement with other geologists and seismologists that the tremors were caused by a slight slip along the old fault which delimits the east side of the buried Nemaha mountains. The Nemaha mountain ridge is a faulted ridge of pre-Cambrian rock, for the most part Sioux quartzite, which extends from north to south under eastern Nebraska and Kansas. It has been described and discussed recently by the writer[1] in connection with the pre-Pennsylvanian structure and stratigraphy of Nebraska.

The top of the escarpment of this buried pre-Cambrian mountain ridge stands about 1,500 feet above the downfaulted basin east of the fault at Nehawka, Nebraska, and it is more than 3,100 feet high in the vicinity of Du Bois, Nebraska, at the Nebraska-Kansas state line. This entire mountain range is completely buried under Paleozoic and younger sedimentary formations. The highest point on the ridge in Nebraska is at Du Bois, where it comes to 558 feet below the surface. It rises about 100 feet higher a few miles south in Kansas. The crest is buried under 1,567 feet of Paleozoic sedimentary formations at Nehawka, and under 1,870 feet of strata at Papillion, Nebraska.

The Nemaha ridge is believed first to have come into existence by folding and faulting during the orogeny which brought the Proterozoic era to a close, that is, during the disturbance which is commonly known as the Killarney-Grand Canyon revolution. The Nemaha mountains are thought to have been a spur from the Sioux Falls "high," and there may even have been a structural as well as a generic connection between these ancient north mid-continent structural features and the long and prominent Killarney mountains, which are supposed to have extended from Minnesota northeastward to the Atlantic.

The first faulting is thought to have occurred at that time, but there is ample evidence that major displacements also took place subsequently during the Paleozoic era following the Ordovician, Silurian, Devonian (?), Mississippian and Permian periods. Apparently the last major displacement took place during or at the close of the Permian period, for Permian formations are faulted with a throw of from 200 to 250 feet in the Humboldt fault in Richardson County. The vertical displacement of the St. Peter sandstone in the vicinity of Nehawka and Nebraska City is at least 1,000 feet, and of the pre-Cambrian Sioux quartzite at least 1,500 feet. The displacement of the older formations is no doubt much greater than this farther south along the ridge. This indicates that the older formations have been further displaced at each later disturbance so that the throw on such formations as the St. Peter has been cumulative during very long periods of geologic time.

[1] A. L. Lugn, *Bull. Amer. Assoc. of Petrol. Geol.*, Vol. 18, No. 12, pp. 1597–1631, December, 1934.

The Nemaha ridge remained an island in the Paleozoic sea, or perhaps it was a chain of islands, while sediments were piling up around and against it. The succeedingly younger systems of rock rest unconformably against the Sioux quartzite and granite by overlap. However, as indicated above, this simple relationship has been complicated by several stages of pronounced faulting, in every case apparently along the same rift or fault zone, which first seems to have come into existence late in the pre-Cambrian.

There is no known evidence indicating that any important displacements have taken place along the Nemaha structure during the Mesozoic and Cenozoic eras. Several mild earthquakes have been experienced during the last hundred years in eastern Nebraska, all or most of them apparently related to this ancient Nemaha structure. It is interesting and significant that this very ancient topographic and structural feature has to a large degree dominated the structural and depositional history of eastern Nebraska and Kansas, and adjacent areas since pre-Cambrian time, and that it apparently is not yet entirely static.

It is evident, in view of the facts stated above, that the region affected by the recent tremors in all probability will experience mild disturbances from time to time. It is also possible but not very probable that it may sometime experience an earthquake of destructive intensity.

The late John R. Freeman[2] regarded the Great Plains, an area of some 600,000 square miles, as the safest from earthquake danger in the United States. However, he thought it probable that this whole great region might experience one earthquake of destructive intensity in a century. Such a "destructive" earthquake would pretty completely wreck things within an area of about 2,500 square miles, according to Freeman. Thus, according to this probability, such centers as Kansas City, St. Joseph, Omaha or Lincoln, or any other single area of 2,500 square miles in the entire Great Plains region, as defined by Freeman, might expect one "destructive" earthquake in 24,000 years.

A. L. LUGN

UNIVERSITY OF NEBRASKA

SYNCHRONOUS FLASHING OF FIREFLIES EXPERIMENTALLY INDUCED

EIGHTEEN previous notes in SCIENCE concerning synchronous flashing of fireflies attest the wide interest accorded this remarkable phenomenon. It has been observed in the Philippines by Purssell[1] and F. Morse[2]; in Siam by Reinking[3] and Morrison[4]; and in this country by E. S. Morse,[5] Allard,[6] Hudson[7] and the Snyders.[8] In addition to these first-hand accounts there have appeared a considerable number of vicarious reports, such as those cited in the reviews of E. S. Morse[9] and Gudger,[10] and in the papers of Blair,[11] E. S. Morse,[12] Van Vleck,[13] Howard[14] and Merril.[15] In view of this large and varied mass of evidence from independent sources it seems to be well established that synchronous flashing of fireflies really occurs.

Several suggestions to explain the phenomenon have been advanced. McDermott,[16] Craig[17] and Gates[18] maintain that it is accidental. However, the chances are enormously against this, for according to all accounts the synchronism involves large numbers of individuals. Many formerly held that puffs of wind influence the insects alternately to expose and conceal their lights, but Allard, Morrison and the Snyders observed flashing in unison during "profound calm." Laurent[19] considers the phenomenon to be due to twitching eyelids of the observer (!), and Craig attributes it to illusion. Wheeler[20] lays the maintenance of the rhythm to an "Einfühlung" or "sympathy" in the insects. The Snyders found that the flashing interval is inversely correlated with temperature, and maintain that synchronism is due to uniformity in temperature, moisture, light and air currents, but they suggest no mechanism whatsoever for getting different individuals into synchronism with each other, asserting that this is purely accidental. Blair and Richmond[21] consider the rhythm to be due to alternate discharge and recovery of a battery-like mechanism, and these observers, together with Newman[22] and Hudson, believe that the flash of a leader sets off the flashes of the rest which build up a synchronism. This contention, and that of Wheeler, are opposed by Morrison, who points out that a "leader" could not be visible to all members of a large swarm, and that the synchronism, once initiated, does not proceed

[2] John R. Freeman, "Earthquake Damage and Earthquake Insurance," McGraw-Hill Book Company, Inc., New York and London, 1932.

[1] John V. Purssell, *Scientific American*, 118: 71, 1918.

[2] F. Morse, SCIENCE, 48: 418, 1918.

[3] Otto A. Reinking, SCIENCE, 53: 485, 1921.

[4] T. F. Morrison, SCIENCE, 69: 400–401, 1929.

[5] Edward S. Morse, SCIENCE, 43: 169, 1916.

[6] H. A. Allard, SCIENCE, 44: 710, 1916.

[7] George H. Hudson, SCIENCE, 48: 573–574, 1918.

[8] Chas. D. and Aleida V'tH. Snyder, *Am. Jour. Physiol.*, 51: 536–542, 1920.

[9] E. S. Morse, SCIENCE, 48: 92–93, 1918.

[10] E. W. Gudger, SCIENCE, 50: 188–190, 1919.

[11] K. G. Blair, *Nature*, 96: 411–415, 1915.

[12] E. S. Morse, SCIENCE, 44: 387–388, 1916; 49: 163–164, 1924.

[13] Hester L. Van Vleck, SCIENCE, 59: 379, 1924.

[14] S. Francis Howard, SCIENCE, 70: 556, 1929.

[15] R. H. Merril, SCIENCE, 71: 132, 1930.

[16] F. Alex. McDermott, SCIENCE, 44: 610, 1916.

[17] Wallace Craig, SCIENCE, 44: 784–786, 1916.

[18] Frank C. Gates, SCIENCE, 46: 314, 1917.

[19] Philip Laurent, SCIENCE, 45: 44, 1917.

[20] W. M. Wheeler, SCIENCE, 45: 189–190, 1917.

[21] C. A. Richmond, SCIENCE, 71: 537–538, 1930.

[22] H. H. Newman, SCIENCE, 45: 44, 1917.

in waves from one or more sources, as maintained by both Allard and Hudson.

It is evident that none of these various notions provides a satisfactory explanation of synchronous flashing. It is the purpose of this paper to present experimental evidence that has a direct bearing on this problem.

Osten-Sacken,[23] McDermott[24] and Mast[25] have studied the mating habits of a number of native species of firefly. In *Photinus pyralis* the male flies about emitting a single short flash about every 5.7 seconds. The female remains in the grass and responds to some nearby male by flashing shortly after each of his flashes. This exchange of signals continues until the male reaches the female and copulates with her. The above investigators did not ascertain how the male distinguishes between the flash of the female and that of another male, but the writer demonstrated conclusively (forthcoming publication) that no possible difference in the light of the two sexes is operative in this discrimination, and that the essential factor involved is the fact that the female (who flashes only in response to the flash of the male) invariably maintains the period of about 2.1 seconds at which she replies to each flash of the male. A striking feature of this "attraction," observed many times by the writer, is that whereas the exchange of signals is initiated by a single pair of insects, other males within range of the female (10 feet) often join in also, so that at times as many as 5 males may fly simultaneously toward the same female, and that under these conditions all these males flash in unison.

Here, obviously, there is some mechanism other than chance which induces males originally out of phase with each other and flashing with different periodicities to break their ordinary rhythms and readjust them to that of the particular male which first responds to the female. The writer has often observed this readjustment of flashing in the field, but the factors involved therein still remain, in spite of considerable investigation, obscure. At any rate the process results in several males responding simultaneously to the same female, whereupon (since their flashing periods are nearly equal) they necessarily flash in unison. Thus it appears that synchronous flashing on a small scale occurs regularly in nature as a normal preliminary to mating.

Precisely the same response on a larger scale can readily be induced by selecting a male, and in proper imitation of the female, flashing a flashlight 2.1 seconds after each of his flashes. In a well-populated region the writer, in this way, has many times attracted from 15 to 20 males simultaneously to the flashlight. It is indeed an impressive sight to see such a group converging through the air toward one point, each member poising, flashing and surging forward in short advances, all in the most perfect synchronism. This extension of the normal phenomenon to a larger number of males is clearly due to the greater intensity of the light produced by the flashlight as compared with that produced by the female.

The facts presented indicate that the observed flashing in unison of large numbers of specimens distributed over a large area is probably produced as follows: A little group of synchronously responding males built up around one female, as described above, acts as a unit in stimulating another female a considerable distance away because the combined intensity of the several simultaneous flashes is greater than that of a single flash; the second female, then, in responding to the first group of males, gathers in to herself a coterie of males which flash in unison and are, of course, synchronized with the original group; they in turn stimulate a third female which "attracts" a third cluster of males, also synchronized with the original, and so on, until a large number of fireflies scattered over an extensive area are flashing in unison. The whole process thus depends on the fact that all the females reply to each of the flashes of the male at the same definite interval.

Several reports (Allard, Hudson, the Snyders, etc.) indicate that the apparent rarity of the phenomenon in large numbers of fireflies is due to the fact that it only occurs under special environmental conditions, such as calm, unusual humidity and darkness, and a large open space crowded with the insects. This fact supports the interpretation presented above, as such conditions would be favorable to the spread of synchronism from group to group, in the manner suggested. The flashing in unison, once established, would probably continue, owing to the normal rhythmic flashing period of the male, until terminated either by some environmental disturbance, such as a breeze (which does actually interfere with the regularity of flashing of the male), or, since luminosity ceases with copulation, by exhaustion of the evening's supply of responding unfertilized females.

JOHN BONNER BUCK

ZOOLOGICAL LABORATORY
THE JOHNS HOPKINS UNIVERSITY

[23] Baron Osten-Sacken, *Stettiner Ent. Zeitung*, 22: 54, 1861.

[24] F. Alex. McDermott, *Canadian Entomologist*, 42: 357–363, 1910; 43: 399–406, 1911; 44: 73, 309–311, 1912; 49: 53–61, 1917.

[25] S. O. Mast, *Jour. Animal Behavior*, 2: 256–272, 1912.

TREE RINGS IN NEW ENGLAND

IN the course of an attempt to determine how well the annual rings of wood in a tree reflect climatic influences in New England, some hemlock tree stumps

at Wolfeboro, N. H., have been found to reveal a logging operation between the growing seasons of 1794 and 1795. The evidence for it appears in the sudden "release" of the then small hemlocks, as shown by the change from suppressed growth and very narrow rings to normal growth and broad rings after 1794.

Although such evidence of release of young trees by removal or death of much larger trees is commonplace to students of forestry, it is thought that the observations here recorded form something of a record in that they date an event in the eighteenth century. A total of 129 annual rings had been formed under the new conditions by each of the six trees chosen at random from about ten times as many cut early in 1924. This precise agreement showed that the release was not due to natural causes but to an act of man, and the history of the site confirmed the idea because it was then adjacent to the cultivated land on the well-known estate of John Wentworth, provincial governor of New Hampshire. From our analyses of other hemlocks on other sites, the release of individual young trees is evident, but, even though growing within a few rods of each other, their sudden increases in rate of growth occur in different years.

It is also possible to make a preliminary announcement that this study of climatic effects on growth rates of the hemlock, *Tsuga canadensis,* has produced positive evidence in favor of a marked control of growth by rainfall *during the growing season.* Drouth years in particular are marked by narrow rings, while seasons with abundant rainfall usually give relatively wide rings. Since the trees used for analysis have as many as 335 rings of wood, the results should add to our knowledge of rainfall in New England well back into the seventeenth century.

This work is being supported in part by a grant from the American Association for the Advancement of Science, and a detailed report of it will appear later. In the meantime, information concerning old growth hemlock stumps and butt logs in New England (with known dates of cutting) will be welcomed as an aid to the collection of accurate data from widely separated sites in the area.

Charles J. Lyon

Dartmouth College

NATIONAL WELFARE, BUSINESS PROFITS AND INDIVIDUAL BENEFIT

In an admirable article in Science (Vol. 81, No. 2090, January 18, 1935, pages 55–62), Professor Wesley Mitchell has presented what may eventually be considered the definitive case for national planning. Although he has neglected the vital distinction between an *oligarchic* "planned" society and a cooperative or *democratic* "planning" society, Professor Mitchell has, I think, demonstrated the inevitability of some kind of large-scale social planning. By whom and for whose good the planning shall be done now becomes the crucial issue.

I am, however, concerned by Professor Mitchell's apparent retention of an outworn theory of motivation as the psychological basis for economic behavior. He states that the "*application* [of scientific discoveries] has been effected *mainly* by men who were seeking profits." By implication, these fundamental discoveries themselves were *not* made because of the driving power of the profit motive. Granted that capitalistic enterprise since the industrial revolution may be equated with the "profit system," it is a defective picture of human nature to assert that even the work of the competitive business world has ever been *mainly* performed under the incentive of profits. At least 95 per cent. of the people (in which I would include most of the readers of Science) make no "profits" in the technical meaning of the term as the positive difference between sales price and cost of production, including administrative salaries. They do, however, secure personal "benefits" and "advantages," *i.e.,* individual "gains," which are an altogether different matter. Human needs demand gratification, but the "need" for profits is a feeble acquired want in most men. The mere existence of technicians and professors who are gratified by an elevation in rank with an accompanying drop in compensation (not a rare combination in recent years!) is sufficient refutation of the strength of the "profit" urge among applied scientists. Certainly industrial psychology and personnel management would be non-existent fields if the lure of an excess monetary reward were the only, or even the principal, factor making for cultural advance.

Economists, executives and advertisers are keenly aware of the reality of "non-financial" incentives. It is, therefore, all the more strange that in philosophizing about the present social order, so many of them make such an inadequate and false distribution of emphasis in cataloging the motives underlying their own activities.

George W. Hartmann

The Pennsylvania State College

CHINESE MAGIC MIRRORS

A recent news item in the *Herald-Tribune* of New York was to the effect that certain scientists had started an investigation as to how the Chinese magic mirrors were constructed. This interested me very much, for I recall how the late physicist, Dr. Thomas Corwin Mendenhall, with whom I was associated on the board of trustees of The Ohio State University, had become interested in the same question while teaching in Japan, how he had discovered

the secret of such magic mirrors, then accidentally made, and how he had demonstrated their manufacture as a possibility. In honor of this discovery the university annual published by the students of Ohio University was called *Makio,* which, I am told, is Japanese for magic mirror.

JOHN KAISER

MARIETTA, OHIO

SCIENTIFIC APPARATUS AND LABORATORY METHODS

HIGH ROTATIONAL SPEEDS IN VACUO

THE need for some simple, inexpensive method of producing high rotational speeds in vacuo has frequently been felt in many fields of experimental science. The air-driven ultracentrifuge has been adapted to supply such a demand. A brief description of its basic features may prove of value.

The rotating member consists of three main parts: (1) a small, conical, air-driven, air-supported turbine;[1] (2) a much larger and heavier rotor of any desired shape, which spins in the vacuum chamber; (3) a steel piano wire extending vertically downward along the axis of rotation from the vertex of the turbine above the vacuum chamber to the larger rotor which it supports and drives. A cross-sectional view of the rotating member, the turbine stator and the cylindrically shaped vacuum chamber is given in Fig. 1. The wire enters the chamber through a special type of brass gland with two holes that leave very slight clearances. Viscous oil slowly forced by a gravity feed into these clearances both lubricates the gland and serves to make it vacuum tight. This lubrication and the small diameter of the wire reduce friction losses to a negligible amount.

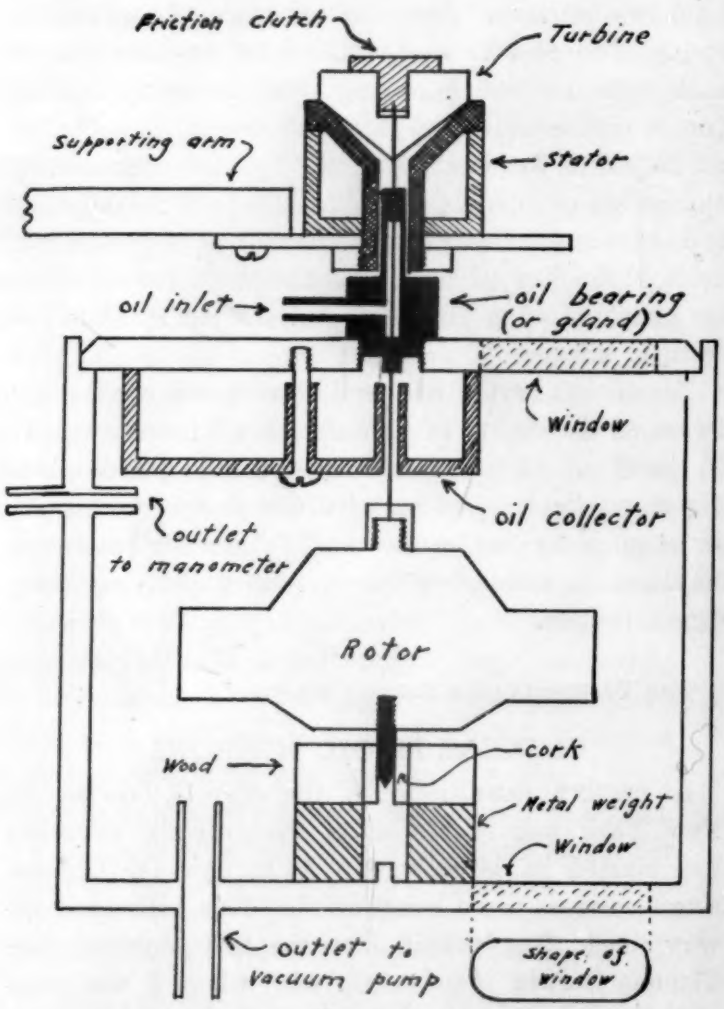


FIG. 1.

To prevent sudden accelerations or decelerations from excessively twisting the wire, it is not fastened to the turbine proper, but passes through a small hole along its axis and is clamped to a friction clutch. The stator is supported by three arms made of light, stiff strips of channel brass, each flexibly mounted and about 6 inches in length. They are provided with ample adjustment for centering, raising or lowering the stator. Fastened to the top, inside the vacuum chamber, is a circular, cup-like container to collect any oil leaking from the gland. A very small disk (not shown in the drawing) attached to the wire just below the gland will throw this oil into the collector and prevent its reaching and clouding any windows in the apparatus. Below the rotor is a circular block composed of metal, wood and cork and arranged as shown in the figure. The rotor is supplied with a steel tip fitting loosely enough into the cork for friction to be negligible. The block is free to move about on the floor of the chamber within a limited range so that it will automatically settle into the correct position when the rotor is spinning. It is heavy enough, however, to prevent undesired precessions from being set up by the rotor.

The rotor becomes vibrationless soon after the turbine is started and the air pressure has been raised sufficiently to support it. It might be noted that great precision in machining and balancing the rotor is not essential, as was well attested by the smoothness with which a 3-inch steel rotor spun after having a ¼-inch hole drilled near the periphery. An air turbine weighing less than 50 grams will rotate an 800 gram rotor at a speed just slightly less than that of the turbine alone. The unguided sections of the wire are not long enough to permit objectionable standing waves being set up. The vacuum obtainable is apparently limited only by the slight vapor pressure of the oil. Oil consumption in the gland amounts to less than 1 cc per hour. In stopping the rotor, wear on the turbine and stator can be minimized by lowering the stator and allowing the rotor to drag on the wooden block below it. Windows are conveniently

[1] See Beams, Weed and Pickels, SCIENCE, 78: 338, 1933; *Journal of Chemical Physics,* 2: 143, 1934.

arranged for observing or photographing any desired operations.

Reference has already been made to articles describing the construction of the air turbine. Some dimensions used in a typical apparatus include: diameter of wire, 0.5 mm; stator of 8 holes made with a No. 60 drill; 3 cm steel turbine with 30 flutings; 9 cm duralumin rotor weighing 450 grams and shaped as shown in the drawing; brass vacuum chamber 5½ inches in diameter, 4¾ inches in height and wall thickness of ¼ inch.

The rotational speed is limited only by the strength of materials. The rotor just described exploded when the speed reached a little above 2,200 revolutions per second. At this speed approximately 12 cubic feet of air per minute (as measured at atmospheric pressure, room temperature) were being supplied to the turbine at a pressure of 70 lbs./in.^{2} The maximum centrifugal force was approximately 900,000 times gravity. The linear speed at the periphery was over 2,000 feet per second, or nearly twice the velocity of sound in air. The kinetic energy of rotation was approximately 3.7×10^{11} ergs, which corresponds to about 8,800 calories.

The method described offers numerous advantages and opportunities for research. The apparatus is simple and inexpensive to build and to operate. Where compressed air is not available, it should be well adapted for operation with other gases or perhaps steam, since the main rotor and the driving mechanism can be easily thermally isolated and controlled. Also slower types of motors could be substituted for driving the rotor if necessary. The flexibility of the wire makes possible an extremely smooth and even rotary motion not usually obtainable otherwise. This, coupled with the fact that the rotation takes place in vacuo, makes the apparatus highly suitable for the centrifuging of solutions and suspensions, especially where the particles separate so slowly that convection currents in the liquid are apt to give trouble. The poor results of many high-speed centrifuge experiments can often be traced to very slight temperature gradients within the rotor which have been introduced through friction or some other external source. The new arrangement allows a considerable increase in both the capacity and the speed of an air-driven centrifuge.

In view of the foregoing facts, we believe the apparatus affords not only a most efficient centrifuge, but a means of investigating many different phenomena.

E. G. PICKELS
J. W. BEAMS

ROUSS PHYSICAL LABORATORY
UNIVERSITY OF VIRGINIA

A NEW METHOD OF DIFFERENTIATION OF AMYLASES AND STARCHES

IN a communication in SCIENCE for October 5, 1934, p. 317, Grace E. Pickford and Frances Dorris have described a micro method for the detection of proteases and amylases. In this connection, it may be of interest to point out that the same method has been developed by the present writer for characterization of different amylases occurring in plant and animal, and that the results of the investigation have already been published in the *Journal of the Indian Institute of Science*.[1]

This method has been extended for the differentiation of various starches. In the course of an investigation on the hydrolysis of different starches by amylases, it was found that the color reactions produced with iodine by the different starches in the course of hydrolysis differ markedly with the kind of starch and also with the concentration of iodine used. These differences in colors obtained with iodine are made use of in the present method. Agar plates impregnated with starch were prepared by mixing equal parts of hot solutions of agar and starch, so that the total concentrations were 1 and 0.2 per cent., respectively, the resultant mixture being spread on a petri-dish and allowed to set. A drop of the amylase solution was then added to the agar plate and allowed to diffuse at the laboratory temperature for about 24 hours. At the end of the period, the starch agar plate was stained with dilute iodine solution (N/100) and the colored zones obtained were observed. The color zones produced differ with different starches and also with the type of amylase used.

In Table I the color zones obtained by different

TABLE I

Starch	Color zones	
	Taka-diastase	Salivary amylase
Potato	Light-green zone surrounded by a violet ring	Colorless zone
Sweet potato	" " "	" "
Rice	Blue zone surrounded by a violet ring	Narrower blue zone
Maize	Central violet zone with a bluish violet zone surrounded by a violet ring	Violet zone
Wheat	" " " " "	" "

[1] K. Venkata Giri, *Jour. Indian Inst. Sci.*, 17A: 127, 1934.

starches by using taka-diastase and salivary amylase have been described.

The amylases used in the present investigation were taka-diastase, 0.5 per cent. (Parke, Davis and Company) and salivary amylase (human saliva centrifuged and diluted 10 times).

From the data given in Table I, which is only a rough indication of the color zones obtained with several starches, it can be seen that tuber starches can be easily differentiated from those of cereals, as the latter give deeper and more differently colored zones than those of tubers. Amongst cereal starches wheat and maize give violet-colored zones. Thus the method affords an easy way of identifying the common starches adulterated in foodstuffs, particularly when the starch is cooked and its structure destroyed, in which case there is no method available in literature for its identification. With the help of a colored chart prepared by the analyst for a number of starches it is possible to identify the individual varieties, whether cooked or otherwise, in which latter case the method is a good supplement to the conventional microscopic method.

K. VENKATA GIRI

INDIAN INSTITUTE OF SCIENCE
BANGALORE

SPECIAL ARTICLES

THE SIGNIFICANCE OF THE PERSISTENCE OF THE CRYSTALLINE STATE ABOVE THE MELTING POINT[1]

THE purpose of this paper is to show that the application of Boltzman's law allows the original objectives of van der Waals to be more effectively pursued. Additional gains in our understanding of liquids are also made thereby. The process of vaporization may be readily visualized on the basis of kinetic theory and by this means Trouton's rule is readily derived. This holds approximately for liquids except those boiling at very low temperatures. One is accustomed to regard the process of fusion as one formally similar to evaporation, each representing a kinetic exchange process across an interface at which an amount of energy is given up by or imparted to molecules crossing the interface. One might expect, therefore, that a Trouton's rule might govern the melting point. For "monatomic" substances, there is a rough approximation to this, but it is not even approximately true for more complex substances. The explanation of these facts must be that in the process of fusion, molecules do not pass over into a state which remains unchanged with increase in temperature until the boiling point is reached, but that the process of fusion represents but a partial breakdown of the crystalline structure. The failure of the van der Waals equation arose from the application of the misconception that molecular forces are of long range, instead of very short-range forces as we now know them to be. De Bye and Keesom, by applying the idea of short-range forces and the well-established Boltzman equation, obtained the expression

$$\overline{U}\rho = \frac{N_A^2}{V}\int \varepsilon(r) e^{-\frac{\varepsilon(r)}{kT}}\, dV$$

for the average energy added to the internal energy of a gas containing N_A molecules in volume V, $\varepsilon(r)$ being the potential energy of two molecules at distance r apart. k is the Boltzman constant. (See Herzfeld's chapter on imperfect gases and the liquid state in Taylor's "Treatise on Physical Chemistry," 2nd edition. van Nostrand Company, 1931.) This equation reduces to that of van der Waals at high temperatures. It is equivalent to the precise equation of state of Onnes. This treatment accounts for deviations from the perfect gas law, not through long-range forces, but through the formation of clusters of molecules. In 1923 C. V. Raman (*Nature*, pp. 428, 532, 1923) utilized a similar idea to account for the viscosities and the temperature coefficient of the viscosities of liquids,

$$\eta_{liq.} = \eta_{vap.} e^{\frac{F}{RT}}$$

where $\eta_{liq.}$ is the viscosity coefficient of the liquid, $\eta_{vap.}$ is that of the vapor and F is the heat of fusion. The perfection of the fit of this equation is very striking for most liquids of not too great complexity. However, the supposition that the energy term F is to be identified with the heat of fusion for all substances is not borne out, and from the foregoing discussion of the process of fusion, this is not surprising and does not condemn the more fundamental elements of Raman's theory. Furthermore, η should be the viscosity of the ideal liquid rather than of the vapor. A large amount of evidence has been accumulating from other quarters to support Raman's concept of the nature of a liquid, which may be consolidated with the present uniform view of the organization of matter. This evidence was reviewed in the 1933 discussion of the Faraday Society on "Liquid Crystals and Anisotropic Melts." There should be mentioned: (a) The x-ray investigations of G. W. Stewart, which led him to believe that ordinary liquids consist chiefly of orderly arranged aggregates of molecules but also in part of molecules having a much more random distribution. (b) The work of Ornstein and his collaborators, who arrived at a similar view of the structure of liquids through investigations of dielectric losses, measurements of dielectric constants in magnetic fields and x-ray investigations of liquids in electric and magnetic fields. (c) And that of Bernal and Fowler (*Jour. Chem. Physics*, I, 515, 1933) on the nature of water. Diffusion coefficients and viscosity coefficients of liquids are related to each other in a reciprocal fashion in accordance with the Einstein-

[1] Read before the National Academy of Sciences, Cleveland, November, 1934.

Sutherland relation (Einstein, *Zeits. Elektrochem.*, 14: 235, 1908) $D = \frac{RT}{6\pi\eta r N}$ (η is the viscosity of the solvent and r is the radius of the solute molecules), whereas in the gas phase the two coefficients are proportional to each other, being related by the equation $D = \frac{\eta}{\rho}$ (Loeb, "Kinetic Theory of Gases," p. 224, McGraw-Hill Book Co., 1923). The former relation assumes the validity of Stoke's law, which is valid for large spheres but for small molecules could not be justified on a kinetic conception of viscosity analogous to that for gases. This should at once suggest that new kinetic factors prevail in the liquid phase. It is apparent that the micro-crystals which augment viscosity in proportion to the fraction of the volume which they occupy will hinder diffusion to a corresponding degree, and thus account for the reciprocal relation. The concept of micro-crystals should shed its light upon other properties of liquids. Thus their resolution into single molecules with increasing temperature would add a term to the specific heat expression for a liquid. The measured compressibility of a liquid is a composite of the compressibility of the liquid and microcrystalline portions. The micro-crystals in liquid surfaces offer centers for catalytic action which would not have been suspected without them. These questions have not been developed sufficiently for presentation.

ROBERT E. BURK

WESTERN RESERVE UNIVERSITY

THE ETIOLOGY OF EPIDEMIC COLDS IN CHICKENS*

DEBLIECK[1] was the first scientist to report on the cause of colds in the chicken. This investigator discovered a hemophilic bacterium which appeared to be involved in the disease in Holland. The first American investigator to report on a similar disease was Nelson.[2] This worker found a Gram negative bacterium which appeared to be responsible for the outbreaks investigated. The chickens affected with this disease did not appear sick, and there was no mortality. Production was seriously affected; and some of the birds showed a bilateral discharge, while distinct gurgling sounds were heard in the trachea. At necropsy considerable exudate was found in the nasal passages, the infraorbital sinuses and the trachea. The disease was transmitted to healthy birds by fresh tracheal exudate from diseased birds and by a hemophilic bacterium isolated from the exudate on culture media.

Delaplane and Stewart,[3] working independently and at the same time as DeBlieck and Nelson, found a Gram negative hemophilic bacterium which they considered to be the cause of a serious outbreak in Rhode Island. The symptoms were those of an exudative rhinitis and sinusitis with little involvement of the larynx, trachea or bronchial tubes. The eyes, turbinates and infraorbital sinuses showed various degrees of inflammation. The mortality in the Rhode Island outbreaks was comparatively high.

Lewis and Mueller[4] report a series of experiments which lead them to believe that the agent of the "common cold" in chickens is not a filtrable virus, and further work by Eliot and Lewis[5] indicates that a pleomorphic, hemophilic, Gram negative bacterium is the responsible agent. They suggest the name *Hemophilus gallinarum* for the microorganism. In their filtration experiments Lewis and Mueller used Berkefeld, Mandler, Chamberland and Seitz filters with negative results.

Six widely separated outbreaks of coryza or colds in chickens have been studied in Massachusetts, using both bacteriological and filtrable virus methods. Five of these outbreaks presented symptoms similar to those described by Nelson, and one in a flock of game birds was like that described by Delaplane and Stewart. A hemophilic streptococcus was isolated from one,[6] a hemophilic bacterium from three[7] and no pathogenic microorganisms could be found by cultural methods in two of these outbreaks. Filtrable agents were not demonstrated in any of these cases when Berkefeld, Coors and Seitz filters were used. These findings are in agreement with those of DeBlieck, Nelson, Delaplane and Stewart, in that Gram negative, hemophilic microorganisms may be present in colds of chickens and aggravate the symptoms and lesions of the diseases, as well as taking some part in immunity.

Tracheal exudates from the two outbreaks in which hemophilic microorganisms could not be isolated were studied by means of a series of graded acetic-cellodion filters prepared according to the directions of Cox and Hyde.[8] The causative agent passed successfully through these filters, and was transmitted directly to healthy chickens by intranasal and intratracheal inoculation of bacterial free filtrates. The outbreaks from which the hemophilic microorganisms were isolated occurred before the series of graded acetic-cellodion filters were used in this laboratory and were not tested by this method.

Since there is no satisfactory standard for measuring the size of the pores in the filters used in this

* Contribution No. 214, Massachusetts Agricultural Experiment Station, Amherst, Mass.

[1] L. DeBlieck, *Vet. Jour.*, 88: 9, 13, 1932.

[2] J. B. Nelson, *Jour. Exp. Med.*, 58: 289, 304, 1933.

[3] J. P. Delaplane and H. O. Stewart, *R. I. State Coll. Bul.*, 29: 92, 94, 1934.

[4] M. R. Lewis and E. Mueller, *Jour. Am. Vet. Med. Assn.*, 37: 759, 769, 1934.

[5] C. P. Eliot and M. R. Lewis, *Jour. Am. Vet. Med. Assn.*, 37: 878, 888, 1934.

[6] C. S. Gibbs, *Poultry Sci.*, 12: 46, 48, 1933.

[7] C. S. Gibbs, *Mass. Agr. Exp. Sta. Bul.*, 311: 15, 1934.

[8] H. R. Cox and R. R. Hyde, *Am. Jour. Hyg.*, 16: 667, 728, 1932.

experiment, the size of the coryza virus particles can only be compared with particles of known dimensions which were treated in a duplicate series of filters at the same time and under the same conditions as the tracheal exudates from the chickens. This experiment indicates that the coryza virus particle is smaller than *S. marcescens,* 0.5 by 1.0 μ, Bergey,[9] and larger than the carbon monoxide hemoglobin molecule which has been determined by Northrop and Anson[10] and Svedberg[11] to be about 5 mμ in diameter. Svedberg also found the ovalbumin molecule to possess a diameter of 4.34 mμ. Using these values in connection with Poiseuille's law for determining the radius of the pores in permeable membranes, it has been found that the coryza virus particles pass through acetic-cellodion filters with pores of an estimated diameter of 120 mμ, and are retained by those possessing a calculated pore size of 80 mμ. Therefore, the diameter of the coryza virus particles must be between 80 and 120 mμ. In general this finding is in line with the observations of Bauer and Hughes[11] and Elford,[12] who state that a relatively large group of virus particles has an end-point within these limits.

CHARLES S. GIBBS

THE HEART RATE IN HEAVY WATER

HEAVY water should afford a new method of controlling the rate of physiological processes. We have found that the frequency of pulsation of the excised heart of the frog can be slowed down in 20 per cent. D_2O.

The heart of a winter frog was carefully excised, including the *sinus venosus,* and the base tied to a small glass rod. A fine wire hook was inserted in the apex and attached to a heart lever writing on a kymograph. The heart was immersed in a 2 cc of Ringer's fluid containing approximately 20 per cent. heavy water in a small shell vial. The room temperature was 18–20° C.

The first heart tested was slit in the ventricle to facilitate diffusion, but this treatment rendered the beat rather feeble. After 15 minutes in ordinary Ringer the time for ten beats was 11.3 secs. The vial of D_2O Ringer was then substituted for the control, and the time for ten beats became 16.9 secs. after 5 minutes. The second heart tested was not slit and beat more vigorously. After 6 minutes in H_2O Ringer the time for ten beats was 11.5 secs. It was then immersed in the D_2O Ringer and after 10 minutes the time for ten beats was 27.8 secs. It was then transferred to ordinary Ringer and the time for ten beats was reduced to 20 secs. The third heart tested was placed immediately in the Ringer containing heavy water and after 5 minutes it was beating vigorously once a minute. Seven minutes after immersion the beat was constant at a rate of once every 5 secs. After transfer to H_2O Ringer the heart gave a regular beat every 2 secs. After 10 minutes of this constant rate the heart was replaced in D_2O Ringer in which the pulsations occurred every 3 secs. for 1 minute and then stopped. However, the heart partially recovered when replaced in H_2O Ringer after 7 mins., the rate being once every 2.5 secs. in regular sequence, except for a regular pause every 6 to 8 beats.

Although the scarcity of the heavy water precludes extensive tests at the present time, the slowing down was twice reversed in the third heart, indicating the influence of the heavy hydrogen isotope.

A similar effect has been observed by Mr. H. Z. Gaw[1] in the rate of contraction of the vacuole in a race of *Paramecium caudatum* in 30 per cent. D_2O, in which the vacuole empties every 19 secs. compared to every 11.3 secs. in controls (Temp. 18.8° C.). The slowing of the vacuole is completely reversible after return to ordinary water and it is probable that complete recovery of the heart would occur under conditions of normal circulation. In each case the heavy water has an effect similar to that produced by lowering the temperature. The biological effects of heavy water are what one would expect from the lower energy content[2] of chemical systems involving deuterium.

T. CUNLIFFE BARNES
J. WARREN
OSBORN ZOOLOGICAL LABORATORY,
YALE UNIVERSITY

[9] D. H. Bergey, Textbook, 3rd ed. 116, 117, 1930.
[10] J. H. Northrop and L. M. Anson, *Jour. Gen. Physiol.,* 12: 543, 554, 1929.
[11] T. Svedberg, Kolloid-2, 51: 10, 1930, quoted by J. H. Bauer and T. P. Hughes, *Jour. of Gen. Physiol.,* 18: 161, 162, 1934.
[12] W. J. Elford, *Proc. Roy. Soc. London.* Series B, 109, 360, 1931.

[1] T. C. Barnes and H. Z. Gaw, *Jour. Am. Chem. Soc.* (in press).
[2] H. Urey and G. K. Teal, *Rev. Modern Physics,* 7: 34, 1935.

BOOKS RECEIVED

BLACK, NEWTON H. *An Introductory Course in College Physics.* Pp. viii + 714. 645 figures. Macmillan. $3.50.

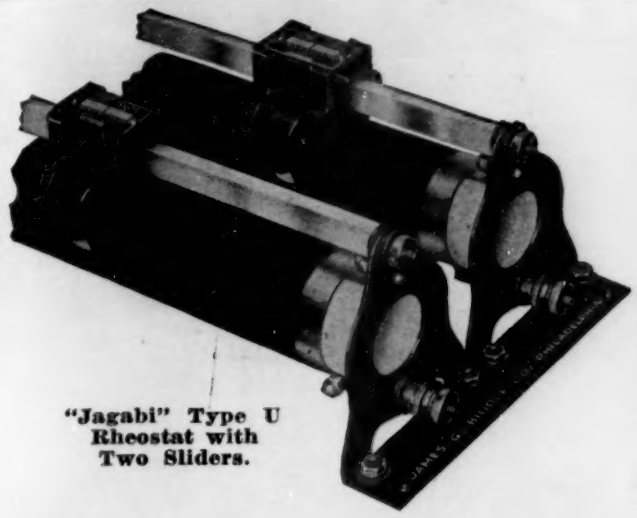
GLENNIE, AGNES E. and GWEN DAVIES. *Index to the Literature of Food Investigation.* Vol. 6, No. 1, March, 1934. Pp. 309. His Majesty's Stationery Office, London. 5s.

PARSONS, G. L. *Scientific Papers and Addresses of the Hon. Sir Charles A. Parsons.* Pp. xxviii + 260. 8 plates. Cambridge University Press, Macmillan. $4.50.

PEATTIE, DONALD C. *An Almanac for Moderns.* Pp. 396. Illustrated by Lynd Ward. Putnam. $3.00.

RICHMOND, DONALD E. *The Dilemma of Modern Physics.* Pp: xiii + 120. 15 figures, 2 plates. Putnam. $2.00.

SNYDER, LAURENCE H. *The Principles of Heredity.* Pp. xiii + 385. 152 figures. Heath. $3.00.



"Jagabi" Type U Rheostat with Two Sliders.

"JAGABI" RHEOSTATS

THESE *improved type* "Jagabi" Rheostats have appealed especially to those users of fine-adjustment current-regulating devices who are primarily influenced by design, quality of workmanship, ruggedness and performance. There are four sizes and 76 different ratings—carried in stock, also a number of special types.

Please write for Catalog 1370-S.

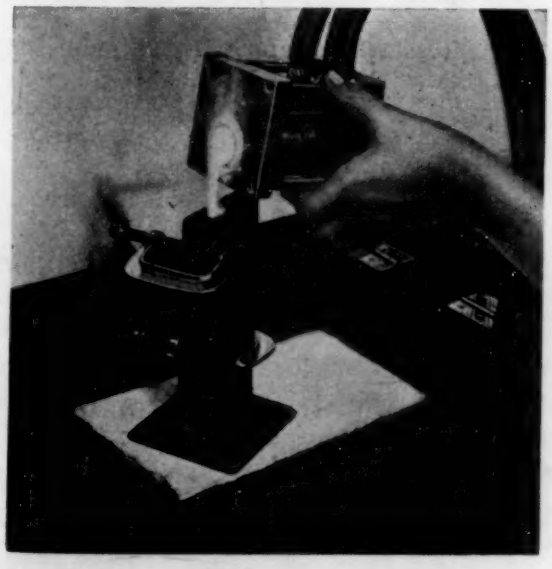
JAMES G. BIDDLE CO.

ELECTRICAL AND SCIENTIFIC INSTRUMENTS

1211-13 ARCH STREET, PHILADELPHIA, PA.

AJAX NORTHRUP

CORELESS INDUCTION FURNACES



Test melts accurately duplicated

Ajax Electrothermic Corporation

Trenton, New Jersey

G. H. CLAMER, *President & Gen. Mgr.*

E. F. NORTHRUP, *V. Pres. & Technical Adviser*

MODERN MARVEL OF PHOTOGRAPHY

Sees all—gets all • Night or day—by the light of your own log fire—in the theatre—by moonlight, even—Leica catches action—gets pictures you never dreamed possible.

Take snapshots in color • The most outstanding development in miniature photography now makes it possible for you to take natural color snapshots with Leica Dufaycolor film—30 exposures for $3.00. No extra accessories needed. Leica leads again.

Learn more about the cat's eye camera • Read about these and many other outstanding features of the Leica, such as its autofocal device which sights and focuses automatically for you, its interchangeable lenses, its focal plane shutter, and other exclusive features. Send a postcard NOW for fascinating FREE BOOKLETS telling about Leica, the camera that has put new freedom into photography.

LEICA MODEL F WITH F:2 SUMMAR LENS

The camera that has put life into photography

Prices start at $99.—U. S. Patent No. 1,960,044

E. LEITZ, INC. DEPARTMENT 17

60 EAST 10th STREET • NEW YORK CITY

OSCILLATOR AMPLIFIER

For HIGH-PRECISION A-C BRIDGES

A 1-WATT supply of power, suitable for high-precision impedance bridges and electrolytic conductivity bridges, is provided by the L&N No. 9842 Vacuum-Tube Oscillator shown above.

Frequencies of 500, 1000 and 2000 cycles per second are provided, and a large number of intermediate and higher frequencies in the audio range can be secured by the use of external condenser and resistor, for which binding posts are provided.

Frequency can be adjusted by the user to 0.1 percent against a frequency standard. This makes the Oscillator very useful in resonance-method measurements.

Frequency stability is better than 0.2 percent when 110-volt, 60 cycle supply voltage fluctuates by ± 15% or less. Stability is not affected by load.

The Oscillator's output is 1 watt into a load of 2000 ohms impedance, at any frequency between 500 and 3000 c.p.s. Wave form is not affected by load impedance.

The oscillator is furnished complete with tubes, and operates on 110-volt, 60-cycle supply. $190.00.

AMPLIFIER No. 9847 is used in detecting the balance of audio-frequency bridges such as are used in measuring the impedances of communication equipment, electrolytes, etc. Voltage sensitivity is at least 3 microvolts, and since the input feeds directly to the grid of a No. 24-A vacuum tube, which has an impedance of the order of megohms, the full voltage sensitivity is attained in practically any audio-frequency bridge. The instrument is "self-blocking" and cannot cause the detector to shriek.

This Amplifier is tunable, and hence amplifies a fundamental frequency far more than it amplifies harmonics and "pick-ups." The latter are thus suppressed, resulting in remarkably sharp and quiet detection of bridge balance. An adjustment for gain control is provided.

The instrument is factory-tuned to 500, 1000 and 2000 cycles. With an outside condenser (for which binding posts are provided) the Amplifier may be tuned to a large number of higher, lower and intermediate frequencies.

The Amplifier is furnished complete with tubes, and operates on 110-volt, 60-cycle supply. $125.00.

This Oscillator and Amplifier are parts of the new line of L&N shielded equipment for a-c. measurements. The line includes resistance boxes of various types and ranges, a ratio box, adjustable air and mica condensers. Information regarding them will be sent on request. Address Section S.

LEEDS & NORTHRUP COMPANY
4900 STENTON AVENUE PHILADELPHIA, PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS AND CONTROL EQUIPMENT

T-323